# *Aldarra Lots M & N Preliminary Plat*

## Level One Downstream Analysis and Preliminary Drainage Control Plan

October 2018

GOLDSMITH
LAND DEVELOPMENT SERVICES

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## Level One Downstream Analysis and Preliminary Drainage Control Plan

Prepared for:
Taconite, LLC


October 2018
Job Number: 16155

GOLDSMITH
LAND DEVELOPMENT SERVICES

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# 1. Project Description

## Purpose and Scope

This report is a Level 1 Drainage Analysis and Preliminary Drainage Control Plan for the Aldarra Lots M & N Preliminary Subdivision. This report accompanies the Preliminary Plat Subdivision application submittal as required by King County. This report meets the requirements of the 2016 King County Surface Water Design Manual (KCSWDM) for drainage review and for a Level 1 downstream analysis of site development plans.

A Pre-Application Conference was held on March 22, 2018 with representatives of King County Department of Permitting and Environmental Review ("DPER"), the applicant (Taconite LLC) and engineer (Goldsmith). Written comments were distributed to provide the applicant and engineer with the applicable code requirements and design criteria to be applied to the Aldarra Lots M & N subdivision.

For this project, a stormwater control plan has specifically been developed encompassing the best available information about the site, surrounding areas, and the downstream system including detailed field investigations as described in Section 3.0. A detailed hydrologic analysis has been completed of the preliminary design approach proposed for stormwater flow and water quality control from the developed site.as presented in Section 4.0.

## Project Location

The Aldarra Lots M & N Preliminary Plat project site (the "Project") location is shown on Figure 1 (Vicinity Map). The site is located in Unincorporated King County in the NW Quarter of Section 7, Township 24 N, Range 7 E, and the SW Quarter of Section 6, Township 24 N, Range 7 E, W.M. at 28212 SE Duthie Hill Road. The 45.08 acre site is zoned R-1-P with R-1-P zoned property located adjacent to the project on all sides (R1 within Sammamish to the West). This project site is located in the Patterson Creek basin within the Snoqualmie Watershed.

## Project Description

This is a request for Preliminary Subdivision approval for 23 single family residential lots, public roads, public utilities (water, sewer, stormwater), and open space / critical area tracts on two existing tax parcels. The Project is comprised of two, existing legal lots (Lot M and N) with a combined area of 45.08 acres per King County Boundary Line Adjustment Number L97L0174, Recording Number 9904229003, and Affidavit of Correction under Recording Number 20010403001504. Theses existing Lots are shown on the Existing Conditions Overall plan (Figure 4). The proposed 23 lot plat layout is shown on the Conceptual Grading and Drainage Plan (Figure 6).

Proposed site development will be on Lot N, while Lot M is proposed as the required open space. Lot N was developed with three single-family residences which were recently demolished. The proposed lots range in size from approximately 18,000 sf. to 58,963 sf. Stormwater control facilities will be designed per the 2016 King County Surface Water Design Manual meeting the core requirements as outlined in Section 2.0. Roads are designed in accordance with the 2016 King

County Road Design and Construction Standards. As the future project will disturb one acre or more, this Preliminary Plat is subject to SEPA.

Key features of the proposed preliminary plat and stormwater control plan include:

- A primary component of the existing residential Plat of Aldarra and the Members Club at Aldarra drainage control system, as approved by King County, is the large stormwater control pond known as DF-R1 located east of the intersection of SR-202 and SE Duthie Hill Rd (see Exhibit 2). The drainage basin that is served by DF-R1 includes the majority of the existing Plat of Aldarra residential subdivisions, a large portion of the golf course, and the Taconite parcel (identified as Tract N in the drainage control plan for the Aldarra development (*TIR for Aldarra Storm Pond DF-R1 and Related Facilities (Goldsmith, 2001*). The use of this facility for flow control and water quality treatment is proposed for the proposed plat of Aldarra Lots M and N.

- The flow control and water quality control features provided by the existing stormwater facility DF-R1 was designed to provide Level 3 flow control and water quality treatment using a combined detention/ wetpond and biofiltration swale design consistent with the 1998 King County Surface Water Design Manual (KCSWDM). Future development of Tract N (Taconite parcel) was included in the design assumptions for DF-R1.

- The project proposes to discharge stormwater runoff to the existing piped system on the east side of the site. Runoff within the existing 36-inch drainage pipe travels east, discharging into the existing regional DF-R1 drainage pond.

- The existing residences and improvements have been recently demolished. Per the P-Suffix Overlay, ES-P20, fifty percent of the site shall be placed within permanent open space. Specifically, Lot M will satisfy the 50% open space requirement. Goldsmith conducted an As-Built survey to verify the existing impervious areas on the existing project site. The calculations of existing impervious areas are provided in the Existing Land Use/ Surface Cover description provided in Section 3.0.

- The site is also subject to Special Overlay ES-P15 which limits development of the ‘Aldarra Property’.

# 2.0 Core Requirements

The following is a preliminary description of how the Preliminary Plat of Aldarra Lots M & N will meet the Core Requirements of the 2016 KCSWDM.

**Core Requirement #1 – Discharge at the Natural Location**
The proposed development will discharge stormwater to the existing 36-inch conveyance system off-site and directly east of the site. Stormwater will be conveyed, treated, and detained at the existing regional combination detention/water quality/irrigation pond DF-R1. This existing system receives site runoff under current conditions; therefore, this project does not propose altering the discharge point to Patterson Creek.

**Core Requirement #2 – Offsite Analysis**
A downstream drainage analysis has been completed and is included in this report (Section 3.0).

**Core Requirement #3 – Flow Control**
Analysis of the existing flow control system designed for the Plat of Aldarra residential and Members Club at Aldarra golf course has been completed and included to this report. The existing flow control facility was designed to mitigate for development of proposed Lot N site development. The project will utilize the existing facility as modified. See Exhibit 1 Pond DF-R1 Plan and Section 3 and 4 of this report for more information.

**Core Requirement #4 – Conveyance System**
The design and analysis of the stormwater conveyance system for this project will comply with the requirements of the 2016 KCSWDM. Detailed design and analysis of the conveyance system will be completed in future Road And Storm Plan submittals.

**Core Requirement #5 – Erosion and Sediment Control**
The design of the erosion and sediment control (ESC) plans for the proposed improvements will be per the requirements of the 2016 KCSWDM and included with future grading plan submittals.

**Core Requirement #6 – Maintenance and Operation**
The proposed on-site storm system elements will be located in public right-of-way and will be maintained by King County. The existing off-site stormwater facilities (including conveyance and stormwater control facilities) will continue to be maintained by the Aldarra Farms Golf Club until such time the off-site storm pond DF-R1 is deeded to the county.

**Core Requirement #7 – Financial Guarantees and Liability**
This project will comply with all financial guarantees required by King County.

**Core Requirement #8 – Water Quality**
The project site is located in an area requiring Basic Water Quality Treatment. The Project proposes to discharge stormwater to the existing combination detention/water quality/irrigation pond within the Aldarra golf course. The existing facilities have been evaluated and discussed further in this report.

**Core Requirement #9 – Flow Control BMP's**
Design and analysis of Flow Control BMP's will be per requirements of the 2016 KCSWDM. Detailed design and analysis of flow control BMP's will be included in future building permit and Road and Storm plan submittals.

# SPECIAL REQUIREMENTS

**Special Requirement #1 – Other Adopted Area-Specific Requirements**
At this time ,the site does not fall under ay other known adopted area specific requirements.

**Special Requirement #2 – Flood Hazard Area Delineation**
This project development is adjacent to a zone A flood hazard area per FEMA Flood Maps. See Exhibit 2 for developed conditions drainage basin plan and 100 year floodplain (per FEMA).

**Special Requirement #3 – Flood Protection Facilities**
This project does not rely on an existing flood protection facility for protection against hazards posed by erosion or inundation, or modify or construct a new flood protection facility; therefore, flood protection facilities are not required.

**Special Requirement #4 – Source Control**
The proposed development does not require a commercial building or commercial site development permit; Therefore, water quality source control is not required.

**Special Requirement #5 – Oil Control**
This project does not have high-use site characteristics; therefore, oil control BMP's are not required.

# 3.0 Downstream Analysis

## Task 1. Study Area Definition

### Existing Land Use / Surface Cover

The Project site is 45.08 acres in size and is shown in the attached aerial photo (Figure 2). The site is located in the Patterson Creek basin within the Snoqualmie Watershed. The project site is located at the easterly boundary of the Plat of Aldarra Division 1, with road stubs provided to the site at both SE 26th Street and SE 24th Way. SE Duthie Hill Road is located adjacent to the site, to the south. The Members Club at Aldarra (private golf club), is located adjacent to and east of the site. Lot N, which is to be developed into the proposed 23 lots, is mostly open field with shrubs and scattered trees. Three existing building structures have been recently demolished on Lot N. Lot M is generally undeveloped and is heavily treed with some open field at the southerly end. A majority of Lot M is wetland area. The existing septic system(s) which served the prior homes (demolished) will be removed / decommissioned as part of the plat infrastructure construction. A former well on the site was decommissioned circa 2002.

**EXISTING IMPERVIOUS AREAS ON ALDARRA LOTS M & N**

| Location | Impervious Area |
|---|---|
| Roof | 13,455 sf |
| Concrete Pavement | 2,070 sf |
| Asphalt Pavement | 41,565 sf |
| TOTAL EXISTING Impervious Area | 57,090 sf |

### Site Soils / Geology

Geotechnical investigations were conducted on the Project site by Terra Associates, Inc. (Geotechnical Report, dated June 11, 2018). The vast majority of native soils observed are interpreted to be glacial ice-contact deposits generally consisting of about 1.5 to 3 feet of medium dense silty sand and gravel, till-like silty sand with gravel, and weakly to moderately cemented outwash-like sand with silt and gravel. There are limited steep slopes on site located near the southern and eastern portions of Lot N. Per the Geotechnical Report, the steep slope areas along the eastern site margin are typically less than 20 feet in height are exempt from the code requirements, while the steep slopes along Duthie Hill Road are recommended to have a 10 foot slope buffer in addition to the required 15 foot building setback. The Geotechnical Report states that no significant active erosion at the site was observed; however, exposed site soils will be susceptible to erosion during development. The Geotech Engineer has indicated that infiltration is not a feasible alternative for management of site stormwater. A copy of the *Preliminary Geotechnical Report, Terra Associates, Inc. dated June 11, 2018* is located in Appendix B.

The U.S.D.A. Natural Resource Conservation Service (NRCS 2014) on line soil survey SCS Soil Map is included as Figure 3. According to the SCS mapping, the site is underlain with Alderwood (AgC & AgD) gravelly sandy loam soils.

### Groundwater

Site investigations conducted for the Project indicate fluctuating perched groundwater at times. Light seepage was observed in three of the test pits. The upper 2 to 10 feet of soil in 11 of the test

pits were mottled or contained scattered iron-oxide stained pockets. (*Geotechnical Report, Terra Associates, Inc. dated June 11, 2018*). See Appendix B.

**Existing Site Drainage Patterns**

The site was occupied by three single family homes which were recently demolished. The existing site topography is shown on the Existing Conditions Map, Figure 4. The Project site is approximately 45.08 acres in size and is located along the west edge of Patterson Creek valley on the east side of the Sammamish Plateau. The ground slopes from west to east, from the Sammamish Plateau towards Patterson Creek. Patterson Creek is located approximately ½ mile east of the proposed development and it flows south to its confluence with the Snoqualmie River about 2 miles southeast of the site.

Topographically, the site is located along the east margin of the East Sammamish Plateau, near the west rim of the Patterson Creek. The southwest portion of the project is relatively flat with moderate slopes ranging from about 3% to 10%. The northern and eastern portions are located on an east facing slope. Slopes can be characterized as moderate to steep, ranging from about 10% to 35%. The local areas within the project with slopes over 40% are not classified as steep slope hazard areas (except along Duthie Hill Road as discussed above), but according to King County iMap, there is an erosion hazard area on the east side and a potential landside area to the north.

## Task 2. Resource Review

The following is a summary of the resources and documents reviewed for this downstream analysis. Relevant maps from these references have been included in the attached appendices as referenced below.

### Sensitive Area Folios

King County iMAP sensitive area mapping was reviewed to identify any potential sensitive areas within, adjacent to, and downstream of the proposed site.

- Wetlands: A majority of Lot M is wetland area. Lot M will be set aside as permanent open space.
- Streams and 100-year Floodplains: There are no streams or floodplains identified on the project site; a flood plain is located adjacent to Patterson Creek, located 3,500ft (0.66 miles) downstream of the site as identified by iMAP data.
- Erosion Hazard Areas: Mapping indicates erosion hazard areas on the project site.
- Landslide Hazard Areas: Mapping identifies landslide hazard areas on Lot M.
- Seismic Hazard Areas: No seismic hazard areas are identified on the project site. Seismic Hazard Area is located downstream of the site, approximately 1,200 feet to the east.
- Coal Mine Hazard Area: No coal mine hazard areas are identified on, or downstream of the project study area.
- Critical Aquifer Recharge Area (CARA): iMAP data indicates a Category 2 CARA beneath a portion of the site.
- Basin Condition: iMAP data indicates the basin condition as high.

### USDA SCS King County Soils Survey

A copy of the USDA SCS King County Soils Survey soils map identifies that soils found on-site and in the immediate vicinity included Alderwood gravelly sand loam (AgC and AgD). See the SCS King County Soils Survey - Figure 3.

### Floodplain / Floodway (FEMA) Maps

Per FEMA Flood Insurance Rate Map No. 53033C0705 F the site is designated as being in Zone “X”, which is an area deemed to be outside of the 500 year flood plain. The FEMA map identifies a Zone A (100-year floodplain) 0.66 miles downstream of the site. This flood plain is associated with Patterson Creek.

### Downstream Drainage Complaints

Downstream drainage complaints were received from King County Water and Land Resources (WLR) Division for the area around and downstream of the project site and reviewed. See Appendix A. These complaints are within the vicinity of the project site, however, not located within the quarter-mile downstream path.

The drainage complaint list was further screened to identify relevant complaints located along the conveyance system downstream of the site. The screening eliminated further review of many complaints based on the physical address of the complaint and based on the comments description. Based on this review, there weren't any specific flooding complaints nor any water quality complaints within the ¼ mile downstream path within the last 10 years. See Appendix A for documented King County complaints near or within the vicinity of the site as reference. The complaint records are closed.

### Other Reports and Information reviewed include:

- *Preliminary Geotechnical Report, Terra Associates, Inc.* dated June 11, 2018

### Topographic and Site Survey Information

- Field survey data for the project site was collected by Goldsmith in March 16, 2018 and included collection of site topography, utilities, buildings, trees, etc.

## Task 3. Field Inspection

A field inspection of the project site and downstream systems was conducted on October 3rd, 2018. Inspections were completed using the guidelines for a downstream analysis as given in Section 1.2.2 of the 2016 KCSWDM. During the time of visit, the weather was dry and sunny, approximately around 60º Fahrenheit.

A Level 1 inspection was completed for the downstream system. The basin boundaries were verified, along with an examination of on-site and off-site drainage conditions and systems. Ground cover, slopes, soil types, and other topographic features were also observed. The downstream analysis typically requires observing the existing conveyance system for a minimum flowpath distance downstream of one-quarter mile. The primary purposes of our field visit was to observe and verify the known downstream path and its conditions.

## Task 4. Drainage System Description and Its Existing and Predicted Drainage and Water Quality Problems

Per the approved *TIR for Aldarra Storm Pond DF-R1 and Related Facilities (Goldsmith, 2001*, as-builts, and a site visit, a closed pipe conveyance system and a stormwater control facility (DF-R1) were constructed for the Aldarra project. These facilities service approximately a 152.1 acre drainage basin that included future development of this project's Lot N area of ___ acres. Consistent with the original design the DF-R1 pond this project will utilization of this off-site stormwater facility

The project proposes to discharge runoff to the existing piped system on the east side of the property as shown on Figure 6. Previous development also included a drainage easement to the project boundary to accommodate future lot development as proposed with this development proposal. Runoff within the existing 36-inch drainage pipe travels east to an existing combination detention/water quality pond located on the Aldarra Farm Golf Course (Pond DF-R1). The outlet configuration of the pond system was designed and analyzed as part of the Members Club at Aldarra golf course Permit. The pond water level is currently controlled by a flow control structure (Exhibit 3). The outlet of the pond discharges into a shallow grasslined swale which was incorporated into the golf course's wetland mitigation area adjacent to Patterson Creek. The swale flows along the edge of the golf course, west of highway 202, before discharging to the existing wetland and eventually flowing to Patterson Creek. The Aldarra Farm Golf Course Pond system was approved by all applicable government agencies and no flooding complaints have been reported since its development, See Figure 5 for the downstream analysis map.

The proposed discharge location for the site is located at the southeast corner of the property. Discharge will be to an existing drainage structure and conveyance system constructed with the existing residential Plat of Aldarra and the Aldarra Farms Golf Club. During the field inspection the structure was located and the lid was opened to verify its conditions. Runoff from this structure flows east through 36-inch pipe. Structures along the flow path were identified up to the quarter mile downstream distance from site. The inspection proceeded past the quarter mile to the existing DF-R1 detention pond. The pond outfall pipe could not be observed due to vegetation around the pond. As observed, the water level seemed to be five to six feet from the bottom consistent with the designed water quality levels. The flow control structure was located east of the pond where runoff is piped to the existing water quality swale south of SE Duthie Hill Rd. The open channel is heavily vegetated with blackberry bushes. At the time of visit, the swale was dry but open channel appears to be adequate for flow and treatment.

The Level 1 Analysis field inspection did not reveal any apparent or significant problems with respect to hydraulic capacity, overtopping or flooding, siltation, erosion, or damage within the observed downstream system.

The following gives a detailed description of the drainage system downstream of the site.

## Task 5. Mitigation of Existing or Potential Problems

A site development plan mitigating for existing and potential drainage related problems has been created. For details of this plan refer to the Preliminary Drainage Control Plan presented in Section 4 of this report.

## OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE -1
### Surface Water Design Manual, Core Requirement #2

**Basin:** Snoqualmie Watershed **Sub-basin Name:** Patterson Creek

| Symbol | Drainage Component Type, Name, and Size | Drainage Component Description | Slope (estimated) | Distance from site discharge | Existing Problems | Potential Problems | Observations of field inspector, resource reviewer, or resident |
|---|---|---|---|---|---|---|---|
| 1 | Site Boundary | Property line | N/A | 0 | None | None | N/A |
| 2 | Conveyance System | Existing 36-inch pipe | 0.5 to 3% | 0-1,700 ft | None | Under Capacity | No capacity problems were observed during site visit |
| 3 | Pond | Existing detention pond. Bottom elevation 92.50 ft, area +/-89,000 sf | 0.5 to 50% | +/-1,700 ft | None | Sedimentation, ponding, flooding | No signs of major sediment, ponding, or flooding |
| 4 | Swale | +/-370 ft biofiltration swale flowing southeast, bottom width is 5'. Water depth 3' | 0.5 to 2% | +/-2,200 ft | None | Sedimentation, ponding, flooding | No signs of major sediment, ponding, or flooding |
| 5 | Swale | +/-415 ft biofiltration swale flowing southeast, bottom width is 5'. Water depth 2' | 0.5 to 2% | +/-2,700 ft | None | Sedimentation, ponding, flooding | No signs of major sediment, ponding, or flooding |
| 6 | Overland/Wetland | Overland flow along Patterson Creek on the west side of highway 202 with mild to flat slopes. | 0.5 to 2% | +/-3,500 ft | None | Sedimentation, ponding, flooding | No signs of major sediment, ponding, or flooding |

# 4.0 Flow Control and Water Quality Facility Analysis

### Preliminary Drainage Control Plan

The stormwater control plan for the site encompasses all available information about the site and its downstream drainage system. This includes site topography, geology, detailed field investigations, and drainage complaints and observations. The Level One Downstream Analysis and Preliminary Drainage Control Plan addresses the off-site pond and conveyance system capacity, the identified flooding problems and potential erosion problems downstream of the site. Preliminary evaluation of the existing flow control and water quality facilities is provided herein. A Preliminary Drainage Plan is shown on Figure 6.

The following describes the preliminary storm drainage design approach of the stormwater control and water quality facilities for the project.

### FLOW CONTROL STANDARD

The existing Aldarra stormwater facility Pond DF-R1 —*TIR for Aldarra Storm Pond DF-R1 and Related Facilities (Goldsmith, 2001)* was submitted in 2001 for the development and mitigation of stormwater runoff from 152.1 acres including the Aldarra residential, and golf course areas and future development of Lot N. Stormwater facilities were designed using the 1998 King County Surface Water Manual to meet the Level 3 flow control standard due to potential impacts to downstream flooding of Patterson Creek. The project proposed the construction of a combination detention/water quality/irrigation pond located on property owned by the Members Club at Aldarra Golf Course. The facility was sized to provide flow control and water quality for a drainage basin that included development and an assumed impervious area for Lot N. See Section 4.0 of this report for detailed information on the existing combination detention/water quality pond.

The 1998 Level 3 standard utilized the King County Rate Time Series (KCRTS) model, a reduced (8 year) period of record continuous model. The standard required that post-developed discharges match **existing** pre-development condition continuous flow durations between ½ of the 2yr level through the 50yr level, and that the 100yr peak flow is matched or reduced.

The Lot N development will utilize the 2016 KCSWDM Conservation (Level 2) Flow Control standard. The 2016 KCSWDM is similar to the 1998 standard; however, the 2016 KCSWDM requires use of extended period of record continuous models such as; WWHM, HSPF, MGS Flood, or other. The 2016 Level 2 flow control standard also requires that post-developed discharges match **historical forested** condition continuous flow durations between ½ of the 2yr level through the 50yr level.

In summary, the DF-R1 stormwater facility is part of the original Aldarra drainage control system designed and constructed in accordance with the 1998 KCSWDM, and included allowances for a future developed condition of Lot N. This facility has been evaluated to provide flow control for the project site to meet the 2016 standard.

### WATER QUALITY STANDARD

The Basic Water Quality treatment for the proposed development is to be provided through the existing water quality control facilities within the Aldarra Farm Golf Course. The approved

stormwater system was designed to treat runoff through the combination detention/water quality pond and biofiltration swale located east of the site. Calculations for WQ included assumed impervious areas for the development of the project at hand. The pond and swale were evaluated to meet current code requirements and deemed adequate for treatment.

The following is the preliminary analysis of the existing DF-R1 stormwater flow control and water quality facility for the Aldarra Lots M & N preliminary plat. This facility has been analyzed to ensure that any adverse impacts from the proposed development on downstream systems are prevented.

## Part A. Existing Site Hydrology

The DF-R1 drainage basin parameters for both pre-developed and post-developed conditions from the 2001 Drainage Control Plan were re-analyzed utilizing the MGS Flood program to establish a baseline condition of the existing system. This analysis indicated that the existing system which was approved and is vested to Level 3 standards using the 1998 KCRTS, does not meet the flow duration and peak discharge control standards when remodeled using the extended continuous time series and MGSFlood as required by 2016 KCSWDM.

Per the Flow Control Applications Map provided by King County, the project is located within a Conservation (Level 2) Flow Control Area. The 2016 KCSWDM requires projects located in a Level 2 flow control area to assume a forested historical site condition for the pre-developed site conditions. The original model land surface data has been modified so the Lot N site is modeled as forested in the existing condition, the remaining DF-R1 basin has been modeled consistent with the existing site conditions used for previously approved DF-R1 design. These assumptions have been used for calculating allowable release rates and flow durations for the existing stormwater control facilities. Existing site hydrology has been modeled using the approved continuous model (MGS Flood). Results of this model are included in Appendix C

| **Predeveloped - Pond Design (1998 KCSWM)** | | **Predeveloped - Pond Analysis (2016 KCSWDM)** | |
|---|---|---|---|
| **Land Cover** | **Area (ac)** | **Land Cover** | **Area (ac)** |
| Till Forest | 30.7 | Till Forest - Lot N area (23 ac.) included | 53.7 |
| Till Pasture - Lot N (23 ac.) included | 103.6 | Till Pasture | 80.6 |
| Till Grass | 6.0 | Till Grass | 6.0 |
| Impervious Area | 2.8 | Impervious Area | 2.8 |
| Closed Depression Reduction (not included) | 9.0 | Closed Depression Reduction (not included) | 9.0 |
| **Total Basin Area** | **143.1** | **Total Basin Area** | **143.1** |

## Part B. Developed Site Hydrology

Per section 1.2.3 of the 2016 KCSWDM, the project is required to match developed discharge durations to predeveloped durations for the range of predeveloped discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow. Developed conditions in the MGS Flood model were updated to meet level 2 forested historical site conditions within this project. The total assumed impervious areas for the new project closely matched the assumed impervious areas used to design the approved detention pond. The existing pond was evaluated utilizing MGS Flood and the information within the approved Technical Information Report for the Aldarra project dated September 2001.

Further analysis was made which modified the pre-developed conditions parameters of the Taconite parcel to "historic conditions" (forested), and the post-developed parameters were modified to include impervious surface levels consistent with the Taconite subdivision proposal. The MGS Flood model was, then, re-analyzed utilizing the modified pre and post-development basin parameters and modifications to the DF-R1 flow control orifices which resulted in discharges complying with the 2016 duration control flow control standards. Re-analysis of the system indicated that modification to the DF-R1 control structure's flow control orifices could be made such that discharges would meet current duration control standards for the originally approved basin pre-developed and post-developed conditions with no other modifications to the DF-R1 pond. Calculations indicate that the existing detention pond and flow control structure can meet the 2016 KCSWDM requirements if the orifice plate within the control structure is replaced, See MGS Flood output at the end of this report.

| **Developed - Pond Design (1998 KCSWM)** | | **Developed - Pond Analysis (2016 KCSWDM)** | |
|---|---|---|---|
| **Land Cover** | **Area (ac)** | **Land Cover** | **Area (ac)** |
| Till Forest | 1.0 | Till Forest | 1.0 |
| Till Pasture | 5.5 | Till Pasture | 5.5 |
| Till Grass | 99.5 | Till Grass | 98.4 |
| Impervious (Aldarra Residential, Golf Course, Duthie Hill Road) | 42.6 | Impervious (Aldarra Residential, Golf Course, Duthie Hill Road) | 42.6 |
| Lot N assumed impervious (15%) | 3.5 | Lot N assumed impervious (20%) | 4.7 |
| **Total Basin Area** | **152.1** | **Total Basin Area** | **152.1** |

## Part C. Performance Standards

Flow Control BMPs

The existing flow control facilities were evaluated per current code requirements using an approved continuous model. The proposed project is mapped in an area required to meet Conservation Flow Control. This is Level 2 flow control based on the forested historical site conditions per the 2016 KCSWDM.

Water Quality Standard

Existing water quality facilities were designed to mitigate for future development of this site. The water quality facilities were examined using the current King County Stormwater Design Manual to meet basic water quality treatment.

## Part D. Flow Control System

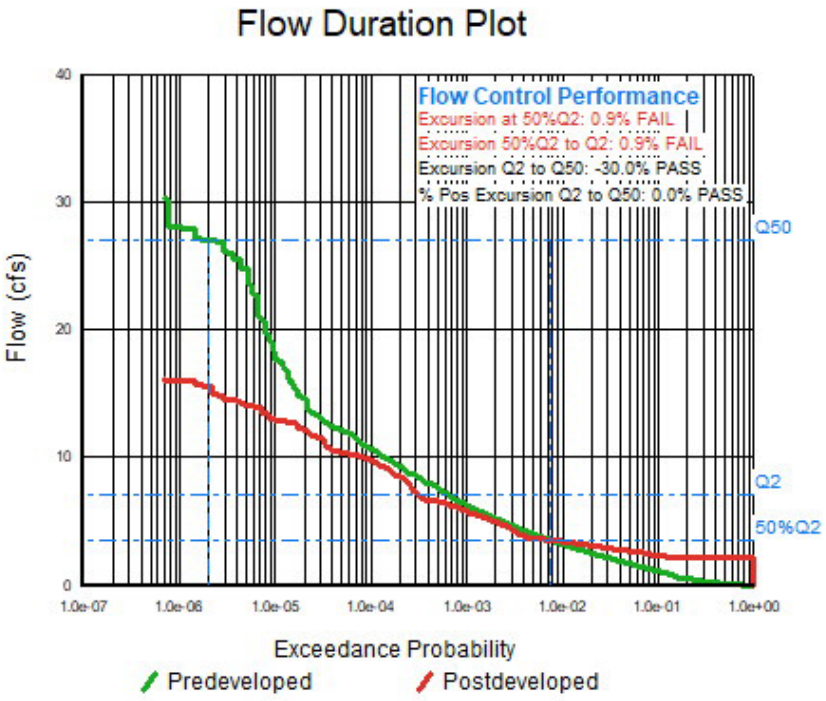
The following provides information related to the evaluation of the existing flow control facilities previously designed for the development of this site. The approved detention pond and flow control structure were designed to provide flow control using the 1998 KCSWDM, meeting Level 3 specific area requirements. The facilities were modeled using MGS Flood to match existing and developed conditions per the approved Aldarra Storm Pond drainage plans. Calculations indicate that the existing facilities do not meet current code requirements for the Lot N site per Level 2 historic forested conditions. Evaluation of the facilities indicate that assumed impervious areas for the development of this site were taken into account for the sizing of the pond. New calculations indicate that the current facilities will meet the 2016 KCSWDM requirements for Lot N if the orifice plate within the flow control structure is replaced with a smaller orifice. See MGS Flood calculations in Appendix C of this report and Exhibit 3 for a detail of the existing control structure.

The following summarizes a comparison of existing and developed Pond DF-R1 discharges and flow durations verifying that the project meets the required flow control standard.

***** Point of Compliance Flow Frequency Data *****
Recurrence Interval Computed Using Gringorten Plotting Position

| Predevelopment Runoff | | Postdevelopment Runoff | |
|---|---|---|---|
| Tr (Years) | Discharge (cfs) | Tr (Years) | Discharge (cfs) |
| 2-Year | 7.049 | 2-Year | 3.747 |
| 5-Year | 11.513 | 5-Year | 5.678 |
| 10-Year | 14.826 | 10-Year | 6.981 |
| 25-Year | 22.946 | 25-Year | 10.816 |
| 50-Year | 26.924 | 50-Year | 13.394 |
| 100-Year | 27.983 | 100-Year | 14.399 |
| 200-Year | 29.546 | 200-Year | 15.551 |

** Record too Short to Compute Peak Discharge for These Recurrence Intervals




## Part E. Water Quality System

As noted above, basic water quality treatment for the site is provided by the existing drainage facilities off-site. The existing pond and biofiltration swales provide enough area to mitigate runoff from the proposed PGIS within the site. The facilities were evaluated using the 2016 KCSWDM and the approved continuous model. As previously mentioned, the facilities were designed to include assumed impervious areas for future development of the site. The MGS Flood calculations show that the pond and swale meet the requirements for water quality treatment. The required Wetpond Volume (per MGSFlood) is 455,997 cu.ft. (10.47 ac.ft)). This is less than the designed Wetpond Volume of13.31 ac.ft.

# *Figures and Exhibits*


# Vicinity Map

28212 SE DUTHIE HILL ROAD

**FIGURE 1**

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Map Data © 2015 Google
L:\2016\16155\5 REPORTS\DRAINAGE\Figures\Figure 1 - Vicinity Map.docx

# King County iMap




Date: 7/11/2018 Notes:

N

King County GIS Center

**FIGURE 2**

Soil Map—King County Area, Washington
(Aldarra Lots M & N Soils Map)


**FIGURE 3**

## MAP LEGEND

**Area of Interest (AOI)**
- Area of Interest (AOI)

**Soils**
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

**Special Point Features**
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

**Water Features**
- Streams and Canals

**Transportation**
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

**Background**
- Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: King County Area, Washington
Survey Area Data: Version 13, Sep 7, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 1, 2011—Jul 15, 2014

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

**FIGURE 3**

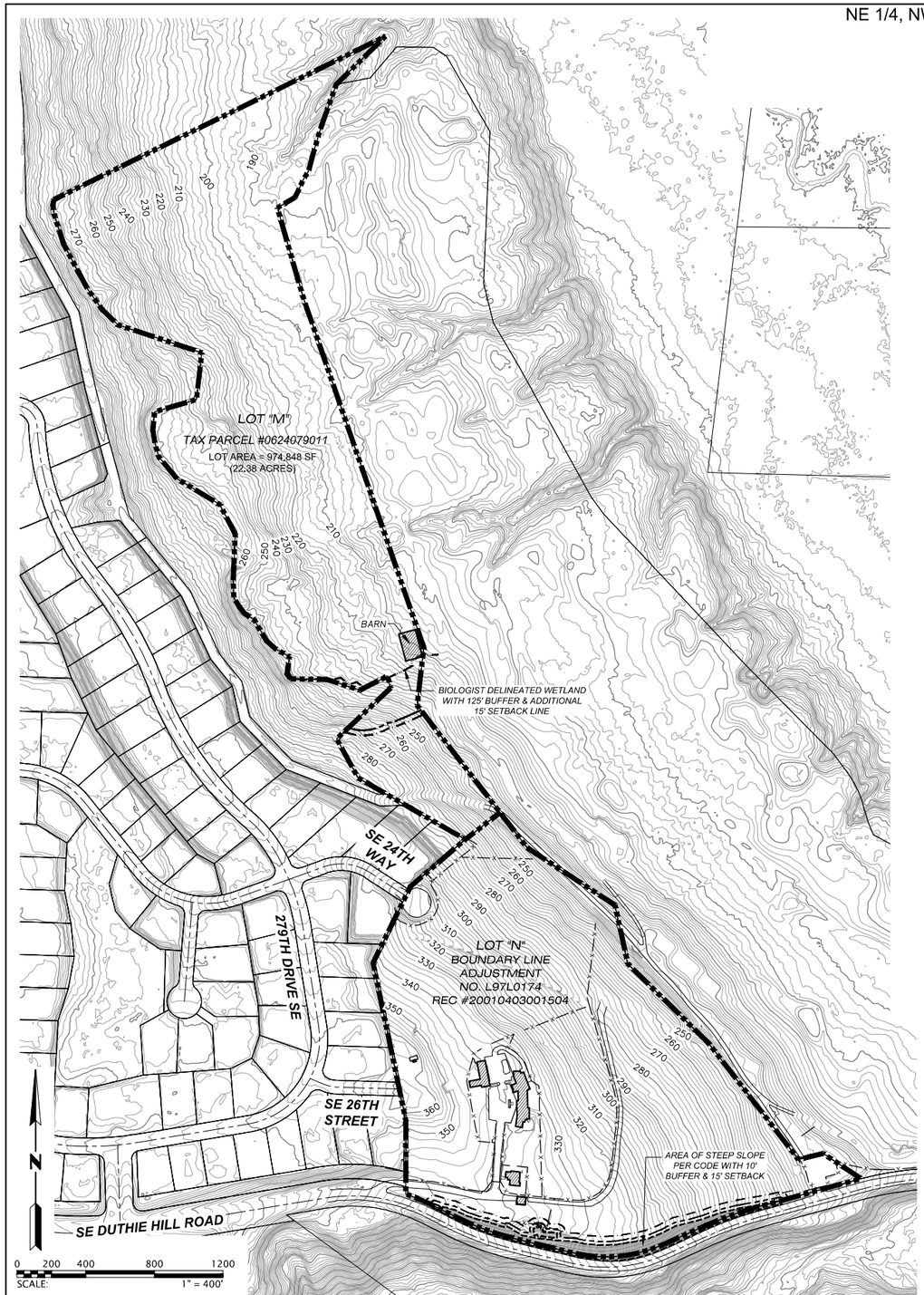
# Map Unit Legend

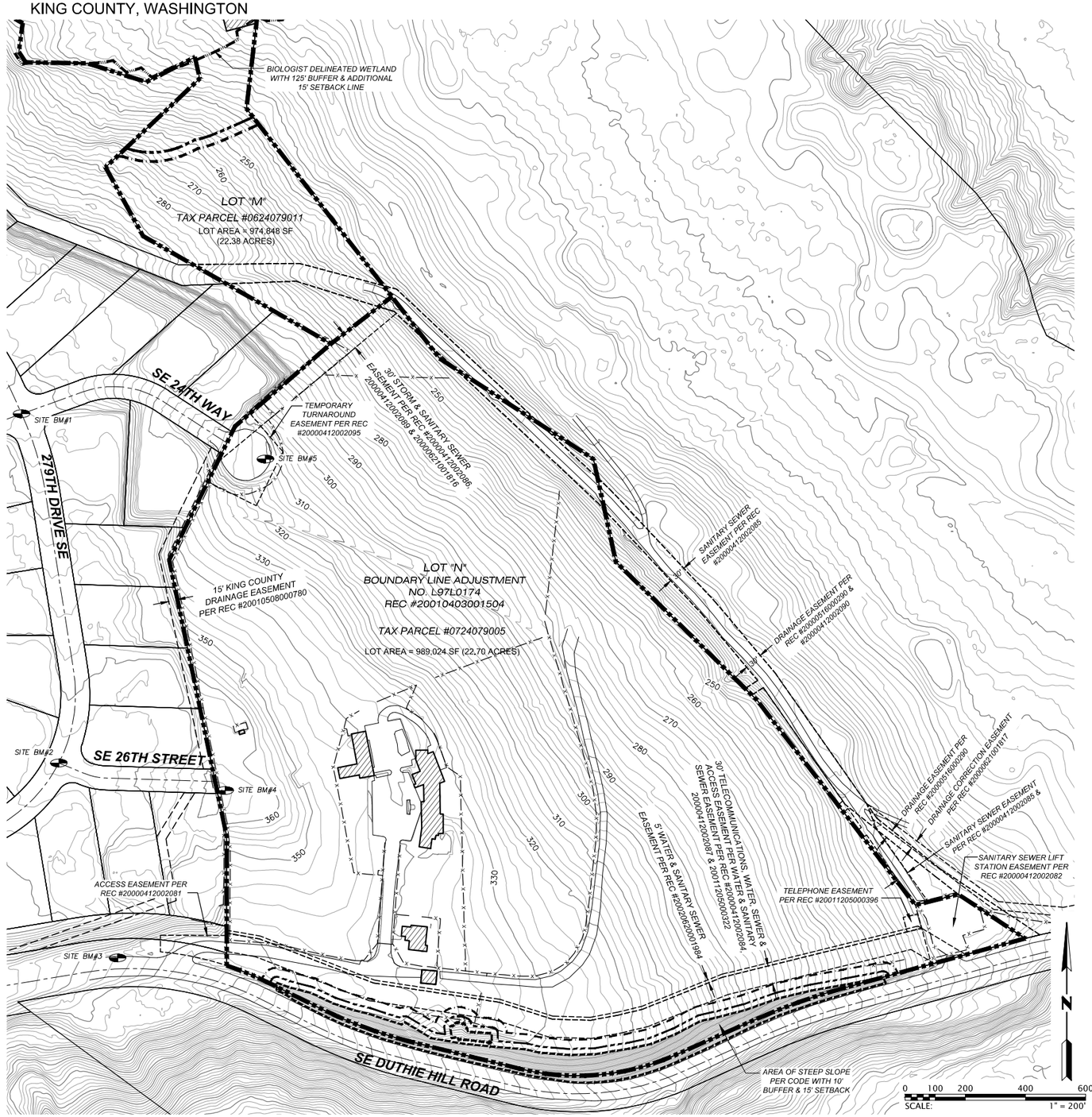
| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| AgC | Alderwood gravelly sandy loam, 8 to 15 percent slopes | 523.8 | 41.0% |
| AgD | Alderwood gravelly sandy loam, 15 to 30 percent slopes | 138.2 | 10.8% |
| AkF | Alderwood and Kitsap soils, very steep | 51.4 | 4.0% |
| Bh | Bellingham silt loam | 30.2 | 2.4% |
| EvC | Everett very gravelly sandy loam, 8 to 15 percent slopes | 73.4 | 5.7% |
| EvD | Everett very gravelly sandy loam, 15 to 30 percent slopes | 12.7 | 1.0% |
| InA | Indianola loamy sand, 0 to 5 percent slopes | 10.2 | 0.8% |
| KpB | Kitsap silt loam, 2 to 8 percent slopes | 249.1 | 19.5% |
| No | Norma sandy loam | 1.7 | 0.1% |
| Pu | Puget silty clay loam | 65.5 | 5.1% |
| Sh | Sammamish silt loam | 54.5 | 4.3% |
| Sk | Seattle muck | 65.5 | 5.1% |
| Sm | Shalcar muck | 1.4 | 0.1% |
| W | Water | 0.0 | 0.0% |
| **Totals for Area of Interest** | | **1,277.7** | **100.0%** |



**FIGURE 3**

NE 1/4, NW 1/4 SECTION 7, TOWNSHIP 24 N, RANGE 7 E, W.M.
KING COUNTY, WASHINGTON




GOLDSMITH
LAND DEVELOPMENT SERVICES
1215 114th Ave SE, Bellevue, WA 98004 | PO Box 3565, Bellevue, WA 98009
T 425.462.1080 F 425.462.7719 www.goldsmithengineering.com

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APPROVED: LN

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KEITH J. GOLDSMITH — STATE OF WASHINGTON — 24097 — REGISTERED PROFESSIONAL ENGINEER

LEE D. NYQUIST — STATE OF WASHINGTON — 38984 — REGISTERED PROFESSIONAL LAND SURVEYOR

TACONITE, LLC

JOB NO. 16155

# EXISTING CONDITIONS OVERALL

## PRELIMINARY PLAT

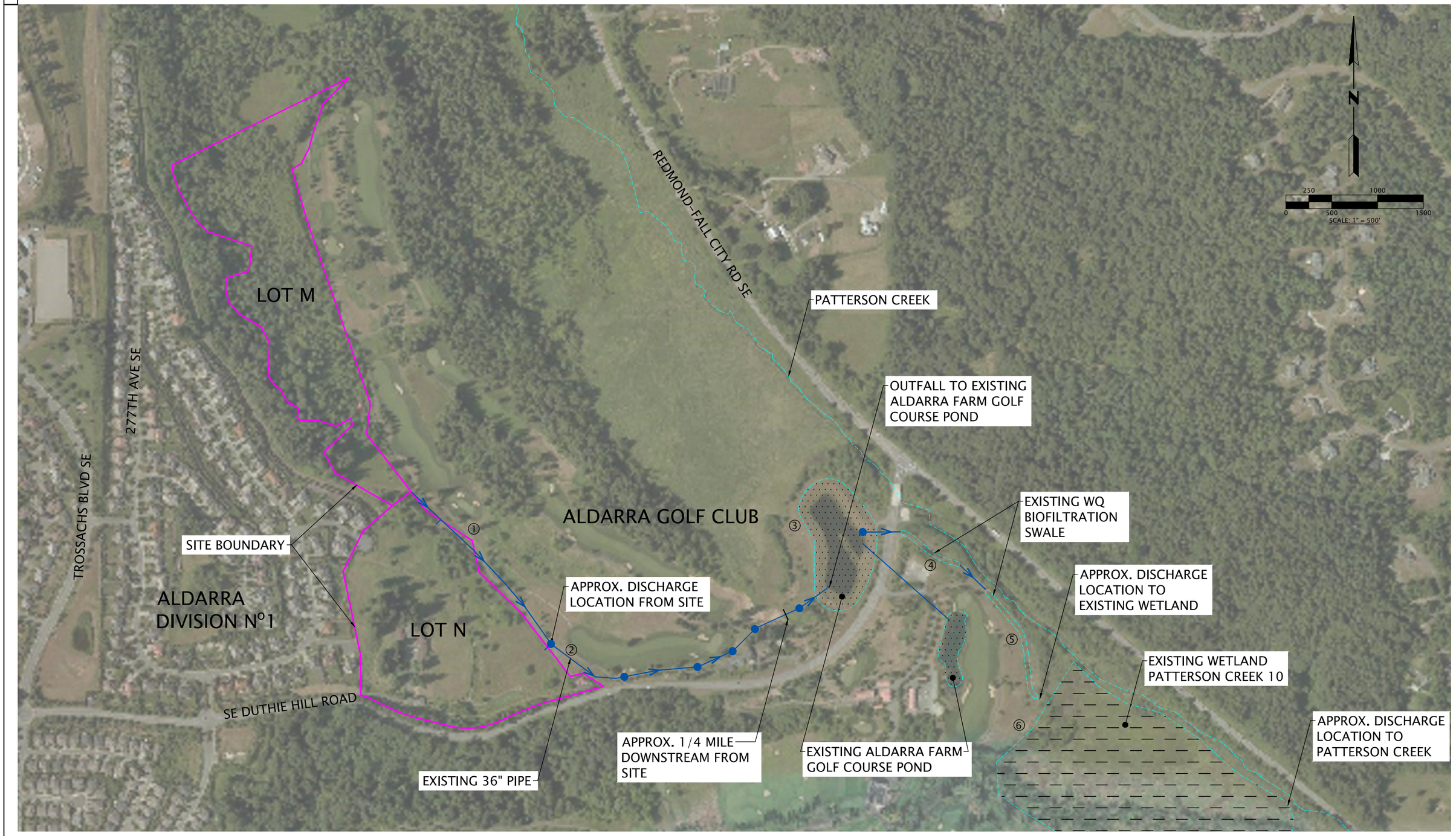
## ALDARRA LOT "N" & LOT "M"

28212 SE DUTHIE HILL ROAD KING COUNTY WASHINGTON

SHEET

**FIGURE 4**

SECTIONS 6 & 7, TOWNSHIP 24 N, RANGE 7 E, W.M.

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T 425-462 1080 F 425-462 7719 www.goldsmithengineering.com

| | |
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| DESIGNED: | CL |
| APPROVED: | KG |

L:\2016\16155\5 REPORTS\DRAINAGE\CAD\16155 – DOWNSTREAM MAP – 2018-07-20.DWG

KEITH J. GOLDSMITH STATE OF WASHINGTON 24597 REGISTERED PROFESSIONAL ENGINEER

MARK A. BARKER STATE OF WASHINGTON 36000 REGISTERED PROFESSIONAL ENGINEER

TACONITE LLC

JOB NO. 16155

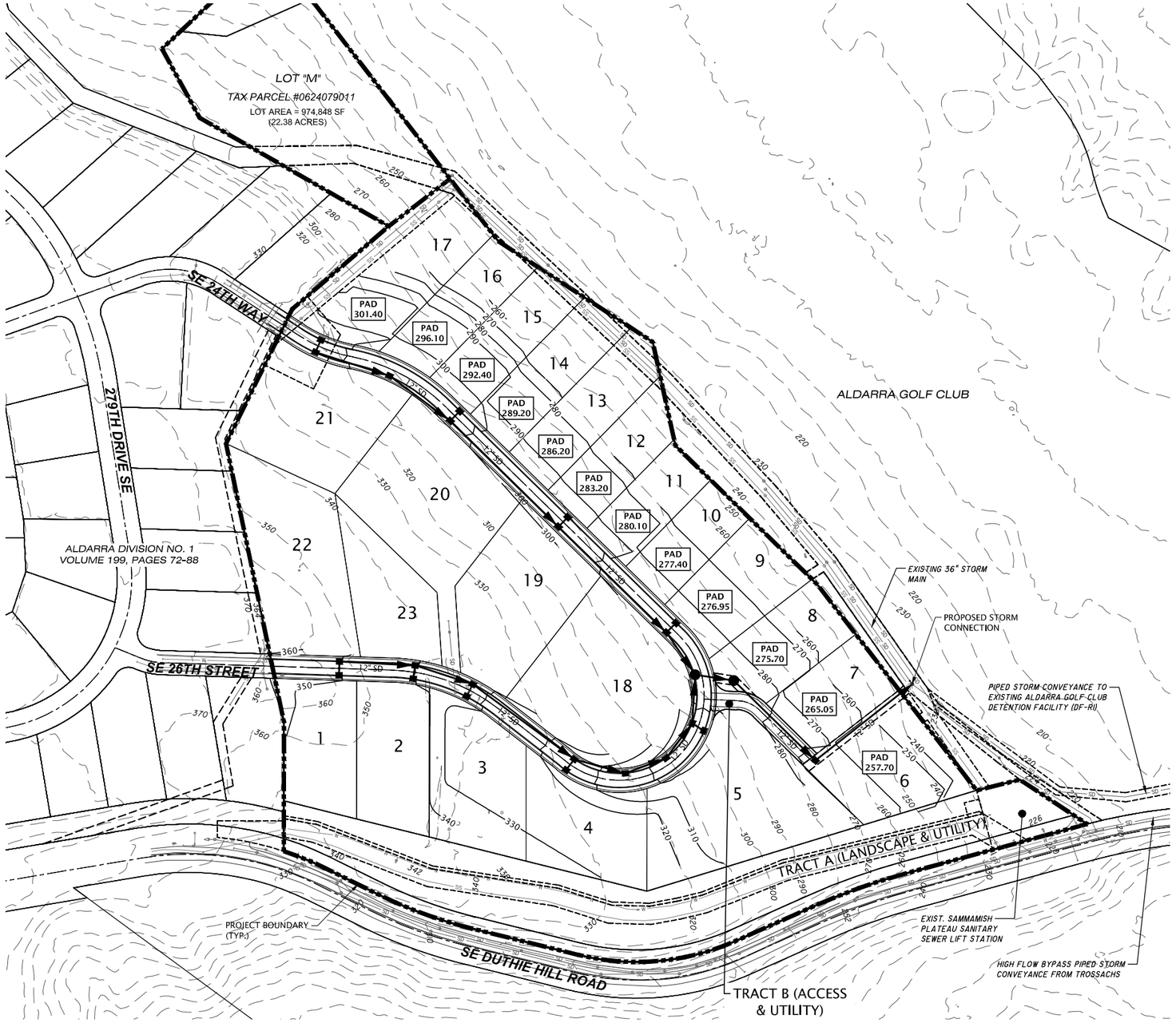
SHEET

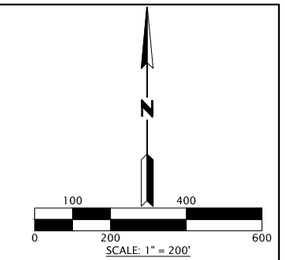
DOWNSTREAM ANALYSIS MAP
FOR
# ALDARRA LOTS N & M

CITY OF SAMMAMISH KING COUNTY WASHINGTON

**FIGURE 5**

NE 1/4, NW 1/4 SECTION 7, TOWNSHIP 24 N, RANGE 7 E, W.M.
KING COUNTY, WASHINGTON




LEGEND

- SD — PROPOSED STORM PIPE
- ● PROPOSED CB TYPE II
- ■ PROPOSED CB TYPE I
- 430 — PROPOSED MAJOR 10' CONTOUR
- 420 — EXIST. MAJOR 10' CONTOUR
- SD — EXIST. STORM DRAIN
- SS — EXIST. SANITARY SEWER
- W — EXIST. WATER MAIN
- Ⓓ EXIST. CB TYPE II
- □ EXIST. CB TYPE I
- Ⓢ EXIST. SANITARY SEWER MH

## PRELIMINARY EARTHWORK CALCULATIONS:

| | |
|---|---|
| TOTAL CUT: | 41,562 CY |
| TOTAL FILL: | 41,089 CY |
| NET = | 473 CY |

## PROJECT DATA:

DRAINAGE BASIN: PATTERSON CREEK BASIN WITHIN THE SNOQUALMIE WATERSHED
PROJECT SITE LOCATED IN SENSITIVE LAKE WATER QUALITY AREA
TOTAL PROJECT SITE: 22.7 ACRES (LOT N)
TOTAL DISTURBED/DRAINAGE AREA: 10.0 ACRES (LOT N)
FLOW CONTROL FACILITY: EXISTING OFF-SITE COMBINATION DETENTION/WQ POND
WQ TREATMENT FACILITY: EXISTING OFF-SITE COMBINATION DETENTION/WQ POND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APPROVED: KG

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KEITH J. GOLDSMITH — STATE OF WASHINGTON — 24097 — REGISTERED PROFESSIONAL ENGINEER

TACONITE, LLC

# CONCEPTUAL GRADING AND DRAINAGE PLAN

## PRELIMINARY PLAT

## ALDARRA LOTS "M" & "N"

28212 SE DUTHIE HILL ROAD KING COUNTY WASHINGTON

JOB NO. 16155

SHEET

**FIGURE 6**

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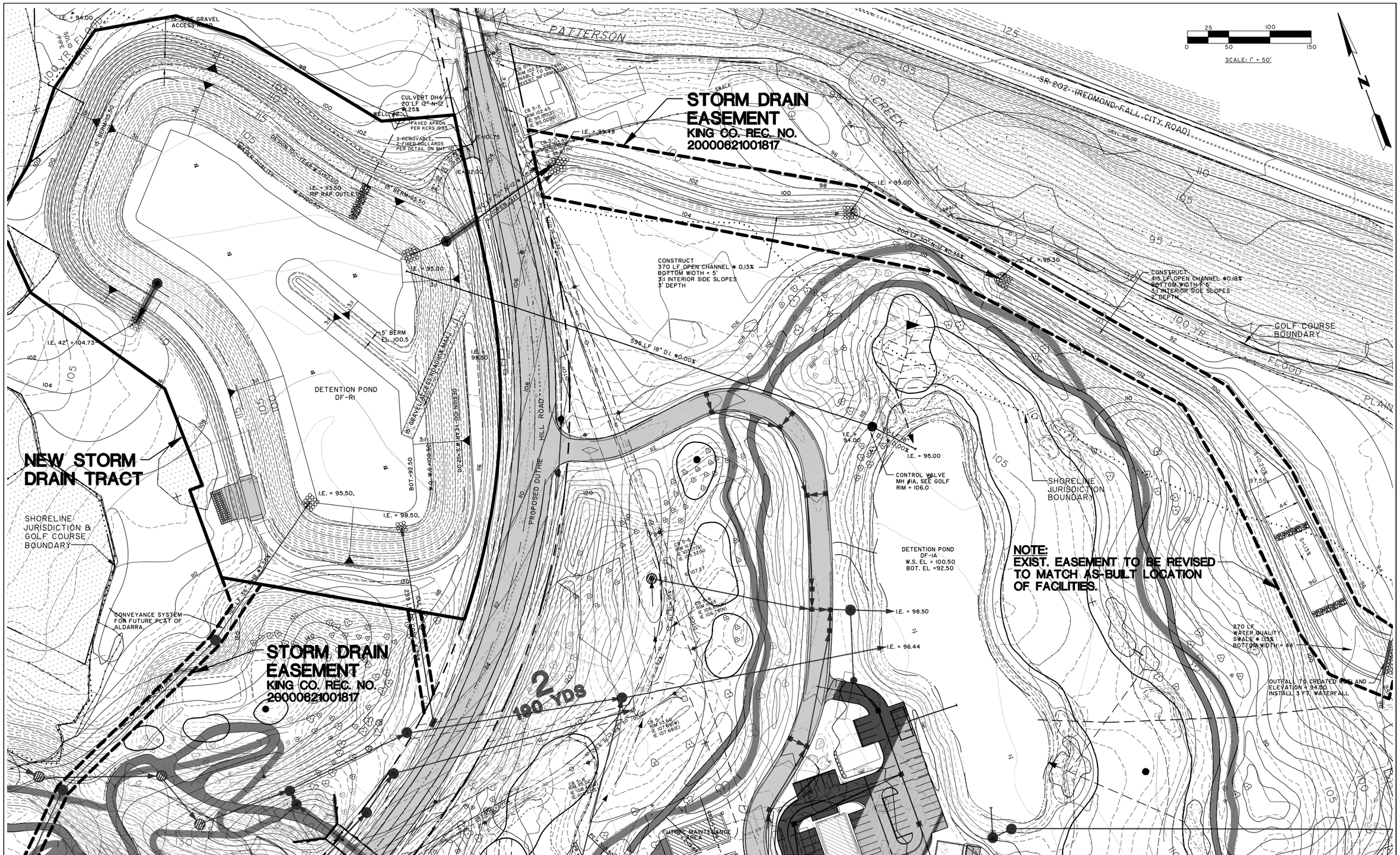



Hugh G. Goldsmith & Associates, Inc.
Consulting Engineers • Surveyors • Planners

1215 114th Avenue SE
Bellevue, WA 98004
P.O. Box 3565
Bellevue, WA 98009

TEL: (425) 462-1080
FAX: (425) 462-7719


| REV. NO | DATE | DESCRIPTION | MADE BY | CHECKED |
|---|---|---|---|---|
| | | | | |

HUGH G. GOLDSMITH — STATE OF WASHINGTON — 6422 — REGISTERED PROFESSIONAL ENGINEER — EXPIRES 10/9/

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| DATE: | NOV. 2000 | XREF: | |
| DRAWN: | ETE | LIF: | |
| DESIGNED: | ETE | FLD BK: | |
| APPROVED: | TMU | PG #: | |
| ACAD DWG.: | 97076E07 | PSSF: | |

ERIK T. ENSTROM — STATE OF WASHINGTON — 38160 — REGISTERED PROFESSIONAL ENGINEER — EXPIRES 7/17/

THOMAS M. UREN JR. — STATE OF WASHINGTON — 21158 — REGISTERED PROFESSIONAL ENGINEER — EXPIRES 9/15/

THE MEMBERS CLUB AT ALDARRA

MEMBERS CLUB AT ALDARRA GOLF COURSE
DETENTION FACILITY/OUTLET EASEMENT EXHIBIT

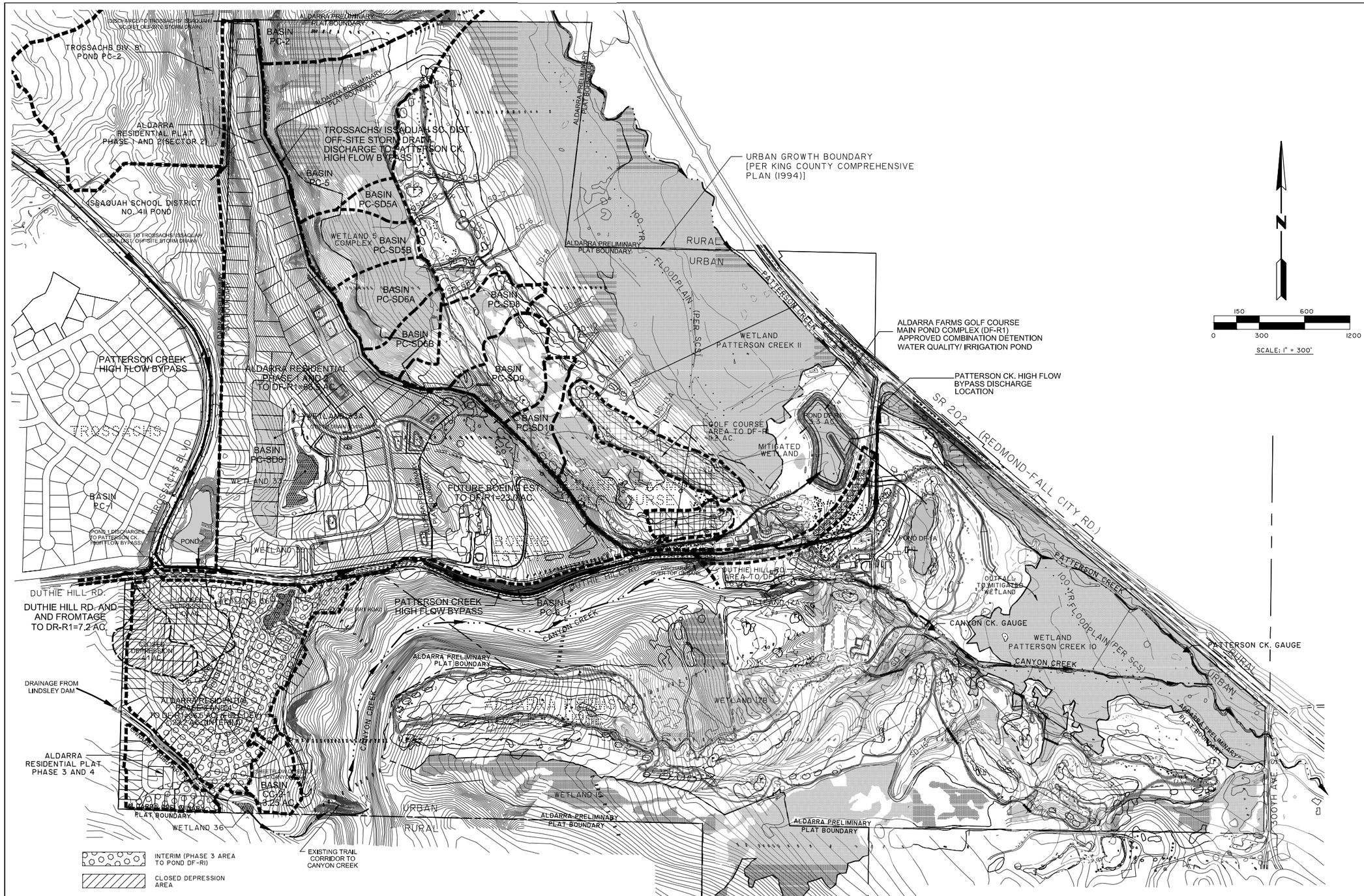
POND DF-RI PLAN

KING COUNTY — WASHINGTON

JOB NO. 97076

SHEET

**EXHIBIT 1**

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Bellevue, WA 98009
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|---|---|
| SCALE: | 1" = 300' |
| DRAWN: | M.A.B |
| DATE: | MARCH 2000 |
| APPROVED: | M.A.B. |
| XREF DWGS.: | |
| DESIGNED: | M.A.B. |
| ACAD DWG.: | 99590E08 |

MARK A. BARBER — STATE OF WASHINGTON — 36000 — REGISTERED PROFESSIONAL ENGINEER — EXPIRES 6/12/

THOMAS M. UREN JR. — STATE OF WASHINGTON — 21189 — REGISTERED PROFESSIONAL ENGINEER — EXPIRES 9/15/

JOHN F. BUCHAN HOMES

DEVELOPED CONDITIONS DRAINAGE BASIN PLAN
FOR
# THE PLAT OF ALDARRA

KING COUNTY WASHINGTON

JOB NO. 99590

SHEET

EXHIBIT 2

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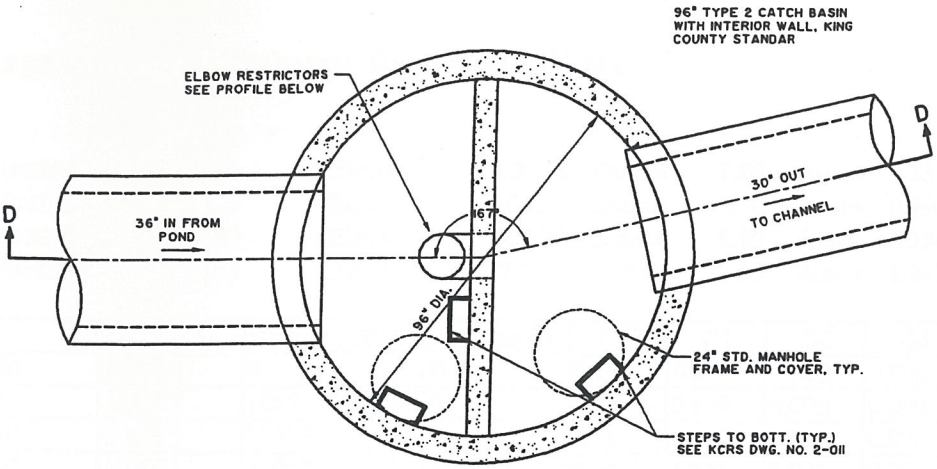
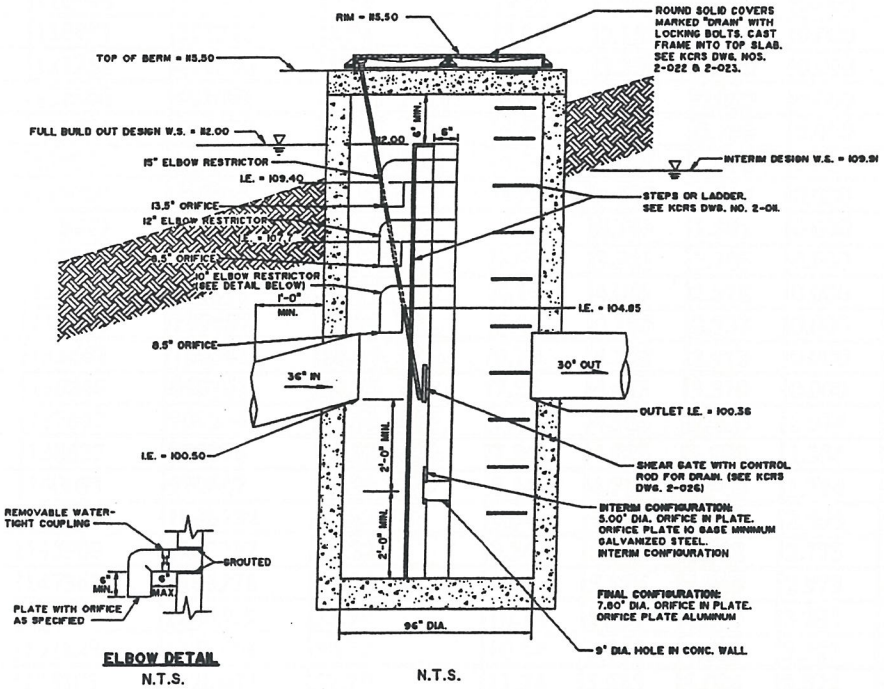



POND DF-RI

CONTROL STRUCTURE - PLAN VIEW

N.T.S.




ELBOW DETAIL

N.T.S.

N.T.S.

POND DF-RI

CONTROL STRUCTURE - PROFILE VIEW

N.T.S.

**EXHIBIT 3**


# Vicinity Map

28212 SE DUTHIE HILL ROAD

**FIGURE 1**

GOLDSMITH
LAND DEVELOPMENT SERVICES

Map Data © 2015 Google
L:\2016\16155\5 REPORTS\DRAINAGE\Figures\Figure 1 - Vicinity Map.docx

# *Appendix A*

## King County Water & Land Resources Division Drainage Complaint Investigation Sheets

# King County Water and Land Resources Division - Drainage Services Section

## Complaint Search

Printed : 7/11/2018 8:52:12 AM

| Number Complaint | Type Type | Type of Problem Code | Address of Problem Type of Problem | | | | Comments Address of Problem | Comments | Tbros Page |
|---|---|---|---|---|---|---|---|---|---|
| 1995-0158 | WQC | DISCHARG | 292ND | SE | & DUTHIE HILL RD | | DRILLING WASTE INTO R/S DITCH | | 598J2 |
| 1995-0158 | WQE | DISCHARG | 292ND | SE | & DUTHIE HILL RD | | DRILLING WASTE INTO R/S DITCH | | 598J2 |
| 1999-0647 | WQC | WETLAND | | SE | 24 ST/288 AVE | SE | 12/04/2008: File search did not locate any | | 598H2 |
| 2005-0423 | SUP | FRE | SR 202 | & | 292ND AVE | SE | REQUEST TO MAINTAIN IRRIGATION | | 598J2 |
| 2006-0251 | CL | INQ | SR 202 | & | 292ND AVE | NE | CAR ACCIDENT. | | 598J2 |
| 2006-0292 | C | DES | 27906 | SE | 24TH WY | | Erosion to sensitive area? Inv found | | 598H2 |
| 2006-0401 | WQC | WQO | DUTHIE | | REDMOND FALL CITY | | | | 598J2 |

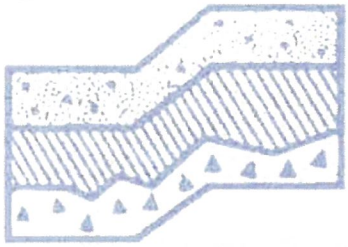
# *Appendix B*

## Geotechnical Report by Terra Associates – June 11, 2018

# GEOTECHNICAL REPORT

**Aldarra Lot N**
**28212 SE Duthie Hill Road**
**King County, Washington**

**Project No. T-7919**



## Terra Associates, Inc.

**Prepared for:**

**Taconite, LLC**
**Seattle, Washington**

**June 11, 2018**

**TERRA ASSOCIATES, Inc.**
Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

June 11, 2018
Project No. T-7919

Mr. David Clough
Taconite, LLC
220 West Mercer Street, Suite W-430
Seattle, Washington 98119

Subject: Geotechnical Report
Aldarra Lot N
28212 SE Duthie Hill Road
King County, Washington

Dear Mr. Clough:

As requested, we conducted a geotechnical engineering study for the subject project. The attached report presents our findings and recommendations for the geotechnical aspects of project design and construction.

The vast majority of the native soils observed in our subsurface explorations are interpreted to be glacial ice-contact deposits generally consisting of about 1.5 to 3 feet of medium dense silty sand with gravel overlying dense to very dense silt with varying amounts of sand and gravel, till-like silty sand with gravel, and weakly- to moderately-cemented outwash-like sand with silt and gravel. The site soils typically contain scattered cobbles and occasional boulders to two feet in diameter. We observed light seepage of perched groundwater in three of the test pits.

In our opinion, there are no geotechnical conditions that would preclude development of the site, as currently planned. The residences can be supported on conventional spread footings bearing on competent native soils on structural fill placed on the competent native soils. Floor slabs and pavements can be similarly supported.

12220 113th Avenue NE, Ste. 130, Kirkland, Washington 98034
**Phone (425) 821-7777** • Fax (425) 821-4334

Detailed recommendations addressing these issues and other geotechnical design considerations are presented in the attached report. We trust the information presented is sufficient for your current needs. If you have any questions or require additional information, please call.

Sincerely yours,
**TERRA ASSOCIATES, INC.**

John C. Sadler, L.E.G., L.H.G.
Project Manager / Senior Engineering Geologist

6-11-18

Theodore J. Schepper, P.E.
Principal

## TABLE OF CONTENTS

# Geotechnical Report
# Aldarra Lot N
# 28212 SE Duthie Hill Road
# King County, Washington

## 1.0 PROJECT DESCRIPTION

The proposed project is a residential subdivision. A draft plan titled Aldarra Lot N Planning Exhibit by Goldsmith, dated May 2018 indicates the development will consist of 23 single-family lots with associated infrastructure and access improvements. The site will be accessed by a new loop road connecting the eastern termini of SE 26th Street and SE 24th Way at the western site margin. Stormwater runoff collected from the development will be detained on-site in a buried vault located in the southeastern portion of the site. The vault footprint is about 240 feet by 90 feet. Proposed vault elevations are not shown on the plan.

Grading plans are currently not available. Based on our conversations with Goldsmith, we understand maximum cuts and fills of about 10 to 12 feet will be required for construction of the loop road.

Building plans are currently not available; however, we expect that the residences will be two- to three-story wood-frame structures with the main floor levels constructed at grade or framed over a daylight basement or crawl space. We anticipate that foundation loads would be relatively light, in the range of 2 to 3 kips per foot for bearing walls and 25 to 50 kips for isolated columns.

The recommendations contained in the following sections of this report are based on these design features. We should review design drawings and specifications as they are developed to verify that our recommendations are valid for the proposed construction, and to amend or modify our report, as necessary.

## 2.0 SCOPE OF WORK

We explored subsurface conditions at the site in 18 test pits excavated to depths about 9 to 15 feet below ground surface using a track-mounted excavator. Using the results of our subsurface exploration and laboratory testing, analyses were undertaken to develop geotechnical recommendations for project design and construction. Specifically, this report addresses the following:

- Soil and groundwater conditions
- Geologic hazards per the King County Code
- Seismic design parameters per the current International Building Code (IBC)
- Site preparation and grading
- Excavations
- Foundations
- Slab-on-grade floors

- Lateral earth pressures for below grade walls
- Infiltration feasibility
- Drainage
- Utilities
- Pavements

It should be noted that recommendations outlined in this report regarding drainage are associated with soil strength, design earth pressures, erosion, and stability. Design and performance issues with respect to moisture as it relates to the structure environment is beyond Terra Associates' purview. A building envelope specialist or contactor should be consulted to address these issues, as needed.

## 3.0 SITE CONDITIONS

### 3.1 Surface

The Aldarra Lot N site consists of a 22.7-acre parcel located north of and adjacent to SE Duthie Hill Road, approximately 850 feet to 2,000 feet east of the intersection with 278th Avenue SE in King County, Washington.

Three residential structures and a detached garage occupy the southwestern portion of the site. We also observed a small structure housing a well adjacent to a buried concrete vault in the west-central portion of the site. The vault is about 12 feet by 24 feet in area and about 10 feet deep, and appears to have been used as a cistern.

Existing surface gradients generally slope down to the east at gentle to moderate inclinations. Surface gradients in the vicinity of the existing residential improvements are relatively flat. Elevation contours shown on the draft site plan by Goldsmith shows surface gradients in the upper western and lower eastern portions of the site typically ranging between about 5 and 25 percent and 20 and 30 percent, respectively.

The road cut for SE Duthie Hill Road has created a steep south-facing slope along approximately 1,100 feet of the southern site margin. The cut is about 10 to 44 feet high with slope inclinations ranging between about 60 and 105 percent. Localized steep slope areas also exist along portions of the eastern site margin where slope grades have been steepened adjacent to an existing utility corridor. The cut slopes in this area are generally about 10 to 20 feet high with slope inclinations of about 50 to 60 percent. We did not observe indications of deep seated instability, significant active erosion, groundwater seepage, or indications of persistently wet surface conditions on the steep slope road cut for SE Duthie Hill Road or the steep slope utility corridor cuts.

Site vegetation generally consists of mature coniferous and deciduous trees, grasses, and brush. The steep slope road cut along SE Duthie Hill Road is typically vegetated with grasses, brush, and moderate growth of coniferous and deciduous trees. The steep slope cuts along the eastern site margin are generally vegetated with grasses, brush, and younger deciduous trees.

## 3.2 Soils

The vast majority of the native soils observed in our subsurface explorations are interpreted to be glacial ice-contact deposits generally consisting of about 1.5 to 3 feet of medium dense silty sand with gravel overlying dense to very dense silt with varying amounts of sand and gravel, till-like silty sand with gravel, and weakly- to moderately-cemented outwash-like sand with silt and gravel. The above soils typically contain scattered cobbles and occasional boulders to two feet in diameter. We observed very dense till and till-like silty sand with gravel in several of the test pits excavated in the south-central and southwestern portions of the site. We observed approximately three feet of fill in Test Pit TP-5 located in the southeastern portion of the proposed stormwater detention vault area. The fill materials generally consist of medium dense silty sand with gravel that contained scattered cobbles and wood debris.

The *Geologic map of the Fall City 7.5-minute quadrangle, King County, Washington*, by J.D. Dragovich, et. al. (2007) shows the upper western portion of the site mapped as Pleistocene deltaic outwash and kame delta deposits (Qgod) and recessional glaciolacustrine deposits ($Qgl_r$), and the lower eastern portion of the site mapped as Vashon till ($Qgt_v$) and Vashon advance outwash deposits ($Qga_v$). As discussed, the vast majority of the site soils are interpreted to be ice-contact deposits with localized areas of till underlying the southwestern and south-central portions of the site.

Detailed descriptions of the subsurface conditions we observed in our site explorations are presented on the Test Pit Logs in Appendix A. The approximate test pit locations are shown on Figure 2.

## 3.3 Groundwater

We observed light seepage of perched groundwater in three of the test pits. The observed seepage occurred from one or more localized point sources between depths of about seven to nine feet. The upper 2 to 10 feet of soil in 11 of the test pits were mottled or contained scattered iron-oxide stained pockets indicating that the soils have been impacted by fluctuating perched groundwater at times.

## 3.4 Geologic Hazards

We evaluated site conditions for the presence of geologic hazards including erosion hazard areas, landslide hazard areas, steep slopes hazard areas, and seismic hazard areas. The King County Code (KCC) does not specifically categorize geologic hazards; however, all the areas listed above are categorized as critical areas per KCC Section 21A.06.254.

### *3.4.1 Erosion Hazard Areas*

Section 21A.06.415 of the King County Code (KCC) defines erosion hazard areas as those areas underlain by soils that are subject to severe erosion when disturbed. These soils include, but are not limited to, those classified as having a severe to very severe erosion hazard according to the USDA Soil Conservation Service (SCS), the 1990 Snoqualmie Pass Area Soil Survey, the 1973 King County Soils Survey, or any subsequent revisions or addition by or to these sources. These soils include, but are not limited to, any occurrence of River Wash ("Rh") or Coastal Beaches ("Cb") and the following when they occur on slopes 15 percent or steeper:

A. Alderwood gravely sandy loam (AgD)

B. Alderwood and Kitsap soils (AkF)

C. Beausite gravely sandy loam (BeD and BeF)

D. Kitsap silt loam (KpD)

E. Ovall gravely loam (OvD and OvF)

F. Ragnar fine sandy loam (RaD)

G. Ragnar-Indianola Association (RdE)

The SCS has mapped the site soils as *Alderwood gravelly sandy loam, 6 to 15 percent slopes (AgC), Alderwood gravelly sandy loam, 15 to 30 percent slopes (AgD),* and *Kitsap silt loam (KpB).* The erosion hazard of AgD soils is described as moderate to severe, which meets the criteria for erosion hazard areas listed above. The SCS describes the erosion hazard of AgC and KpB soils as moderate and slight to moderate, respectively, and therefore do not meet the criteria defining erosion hazard areas.

The mapped location of the AgD soils includes most of the slope located east of the existing residence; however, much of the site areas that are mapped as AgC and KpB soils have surface gradients of 15 percent or steeper, which would also be classified as erosion hazard areas. The approximate locations of erosion hazard areas at the site are shown on Figure 3.

As discussed, we did not observe any indications of significant active erosion at the site; however, the site soils will be susceptible to erosion when exposed during development. In our opinion, the erosion potential of the site soils would be adequately mitigated with proper implementation and maintenance of Best Management Practices (BMPs) for erosion prevention and sedimentation control in the planned development area. BMPs for erosion prevention and sedimentation control will need to be in place prior to and during site development, and should be maintained until permanent site stabilization measures are in place. All BMPs for erosion prevention and sedimentation control should conform to King County requirements.

### *3.4.2 Landslide Hazard Areas*

Section 21A.06.680 of the KCC defines landslide hazard areas as those areas in King County subject to severe risks of landslides including the following:

A. Any area with a combination of:
   1. Slopes steeper than 15 percent.
   2. Impermeable soils, such as silt and clay, frequently interbedded with granular soils, such as sand and gravel.
   3. Springs or groundwater seepage.

B. Any area that has shown movement during the Holocene epoch, from 10,000 years ago to the present, or is underlain by mass wastage debris from that epoch.

C. Any area potentially unstable as a result of rapid stream incision, stream bank erosion, or undercutting by wave action.

D. Any area that shows evidence of or is at risk from snow avalanches.

E. Any area located on an alluvial fan, presently subject to or potentially subject to inundation by debris flows or deposition of stream-transported sediments.

We did not observe conditions meeting the above criteria at the site.

### *3.4.3 Steep Slope Hazard Areas*

Section 21A.06.1230 of the KCC defines steep slope hazard areas as those areas in King County having an inclination of 40 percent or steeper within a vertical elevation change of at least 10 feet. As discussed, the road cut for SE Duthie Hill Road along the southern site margin and localized cut areas adjacent a utility easement that generally parallels the eastern site margin meet the above criteria defining steep slope hazard areas. The approximate locations of these slope areas are shown on Figure 3.

Per Section 21A.24.310(B) (Steep slope hazard areas – development standards and alterations) of the KCC, a buffer is required from all edges of steep slope hazard areas to eliminate or minimize the risk of property damage or injury resulting from slope instability, landsliding, or erosion caused in whole or part by the development. The prescribed minimum width of the steep slope buffer is 50 feet; however, the provisions of the code allow for reducing the buffer based on the findings of a critical areas report prepared by a licensed geotechnical engineer or geologist. Additionally, the code allows steep slope areas that are 20 feet or less in height to be exempt from the code requirements if a report prepared by a geologist or geotechnical engineer determines that no adverse impact will result from the exemption. Based on our review of available topographic information and our field observations, the steep slope areas along the eastern site margin are typically less than 20 feet in height, and in our opinion can be exempt from the code requirements.

The steep slope areas observed at the site appear relatively stable. As discussed, we did not observe any indications of deep-seated instability, groundwater seepage, or significant active erosion on the site slopes, and the slope areas are typically underlain by medium dense to very dense, granular glacial deposits. Our observations of stable site conditions are supported by the results of stability analysis discussed below.

***Stability Analysis***

We performed stability analyses of the steep slope using the computer program Slide 2018. Soil parameters used for our analyses are based on field data and our past experience with similar soils. These parameters are shown on the attached Slide 2018 output. Our analyses were performed for both static and pseudostatic (seismic) conditions on two slope sections identified on Figure 3 as Section A-A' and Section B-B'.

The pseudostatic analysis used a horizontal earthquake coefficient value of 0.2g to model ground motions expected from a severe earthquake. The seismic acceleration was determined for the site using the 2014 U.S. Geological Survey (USGS) National Seismic Hazard Map for a seismic event having a 10 percent probability of exceedance in a 50-year period (475-year return period). The USGS map indicates the subject site is located within an area where the peak horizontal ground acceleration for this return period is expected to range between 0.2g and 0.4g. Our analysis considered a horizontal acceleration equal to one-half of the maximum value of this range. The lowest safety factors determined by our analyses are presented in the following table:

| Section Analyzed | Minimum Safety Factors | |
|---|---|---|
| | Static | Pseudostatic $k_h$=0.2g |
| A-A' | 1.90 | 1.40 |
| B-B' | 2.49 | 1.54 |

The results of the stability analyses indicate that the steep slope areas at the site are stable with respect to deep-seated failure under static and pseudostatic conditions. The safety factors listed above are all higher than the minimum safety factors considered acceptable for stable slopes by local geotechnical engineering practice. The results of the stability analyses are attached in Appendix B.

***Steep Slope Setbacks***

Given our observations of existing stable slope conditions and the results of our stability analysis, and provided the geotechnical recommendations contained herein are followed, it is our opinion that adequate mitigation of potential hazards associated with the steep slope hazard associated with the existing road cut along SE Duthie Hill Road can be achieved by establishing a 10-foot slope buffer in addition to the required 15-foot building setback for total setback distance of 25 feet from the top of the steep slope area. The building lots of the planned development are currently setback about 55 to 60 feet from the slope crest. The location of the recommended slope setback is shown on Figure 3.

### *3.4.4 Seismic Hazard Areas*

Section 21A.06.1045 of the KCC defines seismic hazard areas as those areas in King County subject to severe risk of earthquake damage from seismically induced settlement or lateral spreading as a result of soil liquefaction in an area underlain by cohesionless soils of low density and usually in association with a shallow groundwater table.

Based on the soil and groundwater conditions we observed, it is our opinion that there is no risk for damage resulting from seismically induced soil liquefaction. Therefore, in our opinion, seismic hazard areas as defined above do not exist at the site. In our opinion, design in accordance with local building codes for determining seismic forces would adequately mitigate any impacts associated with ground shaking.

## 3.5 Seismic Design Parameters

Based on the site soil conditions and our knowledge of the area geology, per the current International Building Code (IBC), site class "C" should be used in structural design. Based on this site class, in accordance with the IBC, the following parameters should be used in computing seismic forces:

***Seismic Design Parameters***

| | |
|---|---|
| Spectral response acceleration (Short Period), $S_{Ms}$ | 1.241g |
| Spectral response acceleration (1 – Second Period), $S_{M1}$ | 0.625g |
| Five percent damped .2 second period, $S_{Ds}$ | 0.827g |
| Five percent damped 1.0 second period, $S_{D1}$ | 0.417g |

The above values were determined for Latitude 47.584473°N and Longitude -121.964451°W using the USGS Ground Motion Parameter Calculator web site accessed June 6, 2018 at the web site http://earthquake.usgs.gov/designmaps/us/application.php.

# 4.0 DISCUSSION AND RECOMMENDATIONS

## 4.1 General

Based on our study, there are no geotechnical conditions that would preclude the planned development. The residences can be supported on conventional spread footings bearing on competent native soils underlying organic topsoil and existing fill materials, or on structural fill placed on the competent native soils. Floor slabs and pavements can be similarly supported. Terra Associates, Inc. should review proposed building and grading plans for the project when available to verify that our geotechnical recommendations have been properly interpreted and incorporated into the project design, and to provide additional or alternate recommendations, if needed.

Most of the site soils contain a sufficient amount of fines (silt- and clay-sized particles) such that they will be difficult to compact as structural fill when too wet or too dry. Accordingly, the ability to use the soils from site excavations as structural fill will depend on their moisture content and the prevailing weather conditions at the time of construction. If grading activities will take place during the winter season, the owner should be prepared to import free-draining granular material for use as structural fill and backfill.

Dense silt soils underlie a significant portion of the site at relatively shallow depths. The ability to use the silt as structural fill will depend on the natural moisture content of the material, the prevailing weather conditions at the time of construction, and the ability of the contractor to properly moisture condition the soil. Undisturbed bearing surfaces composed of the native silt or structural fill derived from the native silt would provide suitable support for conventional spread footing foundations, floor slabs, and pavements; however, the soils will be easily disturbed by normal construction activity, particularly when wet. If disturbed, the soil will not be suitable for support, and the affected material would need to be removed with the foundations lowered to obtain support on an undisturbed soil subgrade. Alternatively, the soils can be removed and grade restored with structural fill.

Detailed recommendations regarding these issues and other geotechnical design considerations are provided in the following sections of this report. These recommendations should be incorporated into the final design drawings and construction specifications.

## 4.2 Site Preparation and Grading

To prepare the site for construction, all vegetation, organic surface soils, and other deleterious materials should be stripped and removed from the site. We expect surface stripping depths of about 4 to 12 inches will be required to remove the organic surficial soils in the planned development areas. Stripped vegetation debris should be removed from the site. Organic soils will not be suitable for use as structural fill, but may be used for limited depths in nonstructural areas or for landscaping purposes.

In the developed portions of the site, demolition of existing structures should include removal of existing foundations and abandonment of underground septic systems and other buried utilities. Abandoned utility pipes that fall outside of new building areas can be left in place provided they are sealed to prevent intrusion of groundwater seepage and soil.

Once clearing and grubbing operations are complete, cut and fill operations to establish desired building grades can be initiated. A representative of Terra Associates, Inc. should examine all bearing surfaces to verify that conditions encountered are as anticipated and are suitable for placement of structural fill or direct support of building and pavement elements. Our representative may request proofrolling exposed surfaces with a heavy rubber-tired vehicle to determine if any isolated soft and yielding areas are present. If unstable yielding areas are observed, they should be cut to firm bearing soil and filled to grade with structural fill. If the depth of excavation to remove unstable soils is excessive, use of geotextile fabric such as Mirafi 500X or equivalent in conjunction with structural fill can be considered in order to limit the depth of removal. In general, our experience has shown that a minimum of 18 inches of clean, granular structural fill over the geotextile fabric should establish a stable bearing surface.

We anticipate that most of the site soils will be suitable for use as structural fill provided they are properly moisture conditioned when placed. As discussed, the ability to use the native soils particularly the upper silt as structural fill will depend on the soil's moisture content when excavated, the prevailing weather conditions during site grading, and the ability of the contractor to properly moisture condition the soil. During the normally dry summer months, it may be possible to dry soils that are wet of optimum by aeration; however, we anticipate that significant efforts would be needed to accomplish this. As an alternative, stabilizing the moisture in the native soil with cement or lime can be considered. If soil amendment products are used, additional Temporary Erosion and Sedimentation Control (TESC) BMPs will need to be implemented to mitigate potential impacts to stormwater runoff associated with possible elevated pH levels. Moisture conditioning of silt soils that are dry of optimum would require the addition of water to the soils and thoroughly blending the material prior to compaction. In our opinion, this process would also require significant effort to achieve proper blending of the fine grained materials.

Considering the potential difficulties of managing the moisture content of the silt soils, the contractor should be prepared to import a relatively clean granular material that meets the following grading requirements for use as structural fill and backfill:

| U.S. Sieve Size | Percent Passing |
|---|---|
| 6 inches | 100 |
| No. 4 | 75 maximum |
| No. 200 | 5 maximum* |

*Based on the 3/4-inch fraction.

Prior to use, Terra Associates, Inc. should examine and test all materials planned to be imported to the site for use as structural fill.

Structural fill should consist of properly moisture conditioned material that is placed in uniform loose layers not exceeding 12 inches and compacted to a minimum of 95 percent of the soil's maximum dry density, as determined by American Society for Testing and Materials (ASTM) Test Designation D-698 (Standard Proctor). The moisture content of the soil at the time of compaction should be within two percent of its optimum, as determined by this ASTM standard. In our opinion, reducing the lift thickness to a maximum of six inches and using a sheep's-foot roller to compact the fill will improve the ability to achieve adequate compaction of the fine grained soils.

### 4.3 Slopes and Embankments

All permanent cut and fill slopes should be graded with a finished inclination of no greater than 2:1 (Horizontal:Vertical). Upon completion of grading, the slope face should be appropriately vegetated or provided with other physical means to guard against erosion. Final grades at the top of the slope must promote surface drainage away from the slope crest. Water must not be allowed to flow uncontrolled over the slope face. If surface runoff must be directed towards the top of a slope, it may be necessary to route collected water to an appropriate point of discharge beyond the toe in a closed system.

Embankment fills placed on slopes exceeding a grade of 20 percent must be keyed and benched into competent native soils. A generalized slope fill detail is shown on Figure 4. At a minimum, we recommend constructing a toe drain in the key trench for the fill embankment. The locations and extent of such toe drains will be best determined in the field at the time of construction. All fill placed for embankment construction should meet the structural fill requirements provided in Section 4.2 of this report.

## 4.4 Excavations

All excavations at the site associated with confined spaces, such as lower building level retaining walls, must be completed in accordance with local, state, and federal requirements. Based on the Washington State Safety and Health Administration (WSHA) regulations, existing fill materials and the medium dense to dense native soils would typically be classified as Type C soils. Very dense, cemented till and till-like soils would be classified as Type A soil.

Accordingly, for temporary excavations of more than 4 feet and less than 20 feet in depth, the side slopes in Type C soils should be laid back at a slope inclination of 1.5:1 (Horizontal:Vertical) or flatter. Temporary excavations in Type A materials can be laid back at inclinations of 0.75:1 (H:V) or flatter. If there is insufficient room to complete the excavations in this manner, or if excavations greater than 20 feet deep are planned, you may need to use temporary shoring to support the excavations.

Although not observed in our test pits, seepage of perched groundwater should be anticipated within site excavations completed during the wet winter and spring months. In our opinion, the volume of water and rate of flow into site excavations should be relatively minor and would not be expected to impact the stability of the excavations when completed as described above. Conventional sump pumping procedures along with a system of collection trenches, if necessary, should be capable of maintaining a relatively dry excavation for construction purposes in these soils.

The above information is provided solely for the benefit of the owner and other design consultants, and should not be construed to imply that Terra Associates, Inc. assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

## 4.5 Foundations

The residential structures may be supported on conventional spread footing foundations bearing on competent native materials or on structural fill placed on a competent native material subgrade. Foundation subgrades should be prepared as recommended in Section 4.2 of this report. Perimeter foundations exposed to the weather should bear at a minimum depth of 1.5 feet below final exterior grades for frost protection. Interior foundations can be constructed at any convenient depth below the floor slab.

We recommend designing foundations for a net allowable bearing capacity of 2,500 pounds per square foot (psf). For short-term loads, such as wind and seismic, a one-third increase in this allowable capacity can be used in design. With the anticipated loads and this bearing stress applied, building settlements should be less than one-half inch total and one-fourth inch differential.

For designing foundations to resist lateral loads, a base friction coefficient of 0.35 can be used. Passive earth pressure acting on the sides of the footings may also be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 350 pounds per cubic foot (pcf). We recommend not including the upper 12 inches of soil in this computation because they can be affected by weather or disturbed by future grading activity. This value assumes the foundations will be constructed neat against competent native soil or the excavations are backfilled with structural fill, as described in Section 4.2 of this report. The recommended passive and friction values include a safety factor of 1.5.

## 4.6 Slab-on-Grade Floors

Slab-on-grade floors may be supported on a subgrade prepared as recommended in Section 4.2 of this report. Immediately below the floor slab, we recommend placing a four-inch thick capillary break layer composed of clean, coarse sand or fine gravel that has less than three percent passing the No. 200 sieve. This material will reduce the potential for upward capillary movement of water through the underlying soil and subsequent wetting of the floor slab.

The capillary break layer will not prevent moisture intrusion through the slab caused by water vapor transmission. Where moisture by vapor transmission is undesirable, such as covered floor areas, a common practice is to place a durable plastic membrane on the capillary break layer and then cover the membrane with a layer of clean sand or fine gravel to protect it from damage during construction, and aid in uniform curing of the concrete slab. It should be noted that if the sand or gravel layer overlying the membrane is saturated prior to pouring the slab, it will be ineffective in assisting uniform curing of the slab and can actually serve as a water supply for moisture seeping through the slab and affecting floor coverings. Therefore, in our opinion, covering the membrane with a layer of sand or gravel should be avoided if floor slab construction occurs during the wet winter months and the layer cannot be effectively drained.

## 4.7 Lateral Earth Pressures for Below-Grade Walls

The magnitude of earth pressures developing on below-grade walls will depend on the quality and compaction of the wall backfill. We recommend placing and compacting wall backfill as structural fill, as described in Section 4.2 of this report. To prevent overstressing the walls during backfilling, heavy construction machinery should not be operated within five feet of the wall. Wall backfill in this zone should be compacted with hand-operated equipment. To prevent hydrostatic pressure development, wall drainage must also be installed. A typical wall drainage detail is shown on Figure 5.

With wall backfill placed and compacted as recommended, and drainage properly installed, we recommend designing unrestrained walls for an active earth pressure equivalent to a fluid weighing 35 pounds per cubic foot (pcf). For restrained walls, an additional uniform load of 100 psf should be added to the 35 pcf. To account for typical traffic surcharge loading, the walls can be designed for an additional imaginary height of two feet (two-foot soil surcharge). For evaluation of wall performance under seismic loading, a uniform pressure equivalent to 8H psf, where H is the height of the below-grade portion of the wall should be applied in addition to the static lateral earth pressure. These values assume a horizontal backfill condition and that no other surcharge loading, sloping embankments, or adjacent buildings will act on the wall. If such conditions exist, then the imposed loading must be included in the wall design. Friction at the base of foundations and passive earth pressure will provide resistance to these lateral loads. Values for these parameters are provided in Section 4.5 of this report.

Gravity block or mechanically stabilized earth (MSE) walls can also be used to accommodate vertical breaks in grade that may be required to achieve desired site elevations. We can design or provide soil design parameters for a design build approach for these alternative wall systems, if requested.

## 4.8 Stormwater Detention Vault

Based on our study, we expect that dense to very dense sand with silt and gravel to silty sand with gravel will be exposed throughout the bottom of the vault excavation. Vault foundations supported by these dense to very dense native soils may be designed for an allowable bearing capacity of 6,000 pounds per square foot (psf) provided the bottom-of-footing elevation is at least 8 feet below finished grade. For short-term loads, such as seismic, a one-third increase in this allowable capacity can be used. Friction at the base of foundations and passive earth pressure will provide resistance to these lateral loads. Values for these parameters are provided in Section 4.5.

The magnitude of earth pressures developing on the vault walls will depend in part on the quality and compaction of the wall backfill. We recommend placing and compacting wall backfill as structural fill, as recommended in the Section 4.2 of this report. Lateral earth pressures recommended in Section 4.7 can be used in designing the below-grade vault walls. If it is not possible to discharge collected water at the footing elevation, we recommend setting the invert elevation of the wall drainpipe equivalent to the outfall invert and connecting the drain to the outfall pipe for discharge. For any portion of the wall that falls below the invert elevation of the wall drain, an earth pressure equivalent to a fluid weighing 85 pcf should be used. For evaluating walls under seismic loading, an additional uniform earth pressure equivalent to 8H psf, where H is the height of the below-grade wall in feet, can be used. These values assume a horizontal backfill condition. Where applicable, a uniform horizontal traffic surcharge value of 75 psf should be included in design of vault walls.

The vault may be subject to uplift pressures if drainage is not provided the full depth of the structure. The weight of the structure and the weight of the backfill soil above its foundation will provide resistance to uplift. A soil unit weight of 125 pcf can be used for the vault backfill provided the backfill is placed and compacted as structural fill as recommended above.

## 4.9 Drainage

### *Surface*

Final exterior grades should promote free and positive drainage away from the building areas. We recommend providing a positive drainage gradient away from building perimeters. If a positive gradient cannot be provided, provisions for collection and disposal of surface water adjacent to the structure should be provided.

Surface water from developed areas must not be allowed to flow in an uncontrolled and concentrated manner over the crests of site slopes and embankments. Surface water should be directed away from the slope crests to a point of collection and controlled discharge. If site grades do not allow for directing surface water away from the slopes, then the water should be collected and tightlined to an approved point of controlled discharge.

***Subsurface***

We recommend installing a continuous drain along the outside lower edge of the perimeter building foundations. The drains can consist of four-inch diameter perforated PVC pipe that is enveloped in washed ½- to ¾-inch gravel-sized drainage aggregate that extends six inches above and to the sides of the pipe. The pipe can be laid to grade at an invert elevation equivalent to the bottom of footing grade.

The foundation drains and roof downspouts should be tightlined separately to an approved point of controlled discharge. All drains should be provided with cleanouts at easily accessible locations. These cleanouts should be serviced at least once each year.

## 4.10 Infiltration Feasibility

Based on our study, it is our opinion that on-site infiltration is not a feasible alternative for management of site stormwater due to the presence of relatively-impermeable till and till-like soils, and dense silt at relatively shallow depths beneath the ground surface. In our opinion, the outwash-like sand with silt observed at depth in many of the test pits should not be considered for stormwater infiltration due to its stratified nature and the presence of weakly- to moderately-cemented zones within the soil.

There may be opportunities to infiltrate limited amounts of site stormwater in the medium dense soils observed in the upper 1 to 3 feet of medium dense soil using Low Impact Development (LID) natural drainage practices (NDPs). The feasibility of using NDPs at the site should be based on field conditions observed at the time of site grading.

## 4.11 Utilities

Utility pipes should be bedded and backfilled in accordance with American Public Works Association (APWA) or local jurisdictional requirements. At minimum, trench backfill should be placed and compacted as structural fill as described in Section 4.2 of this report. As noted, the native soils are moisture sensitive and will require careful control of moisture to facilitate proper compaction. If utility construction takes place during the winter or if it is not feasible to properly moisture condition the excavated soil at the time of construction, it may be necessary to import suitable wet weather fill for utility trench backfilling.

## 4.12 Pavements

Pavements should be constructed on subgrades prepared as recommended in Section 4.2 of this report. Regardless of the degree of relative compaction achieved, the subgrade must be firm and relatively unyielding before paving. Proofrolling the subgrade with heavy construction equipment should be completed to verify this condition.

The pavement design section is dependent upon the supporting capability of the subgrade soils and the traffic conditions to which it will be subjected. For traffic consisting mainly of light passenger vehicles with only occasional heavy traffic, and with a stable subgrade prepared as recommended, we recommend the following pavement sections:

- Two inches of hot mix asphalt (HMA) over four inches of crushed rock base (CRB)
- 3 ½ inches full depth HMA over prepared subgrade

The paving materials used should conform to the Washington State Department of Transportation (WSDOT) specifications for ½-inch class HMA and CRB.

Long-term pavement performance will depend on surface drainage. A poorly-drained pavement section will be subject to premature failure as a result of surface water infiltrating into the subgrade soils and reducing their supporting capability. For optimum pavement performance, we recommend surface drainage gradients of at least two percent. Some degree of longitudinal and transverse cracking of the pavement surface should be expected over time. Regular maintenance should be planned to seal cracks when they occur.

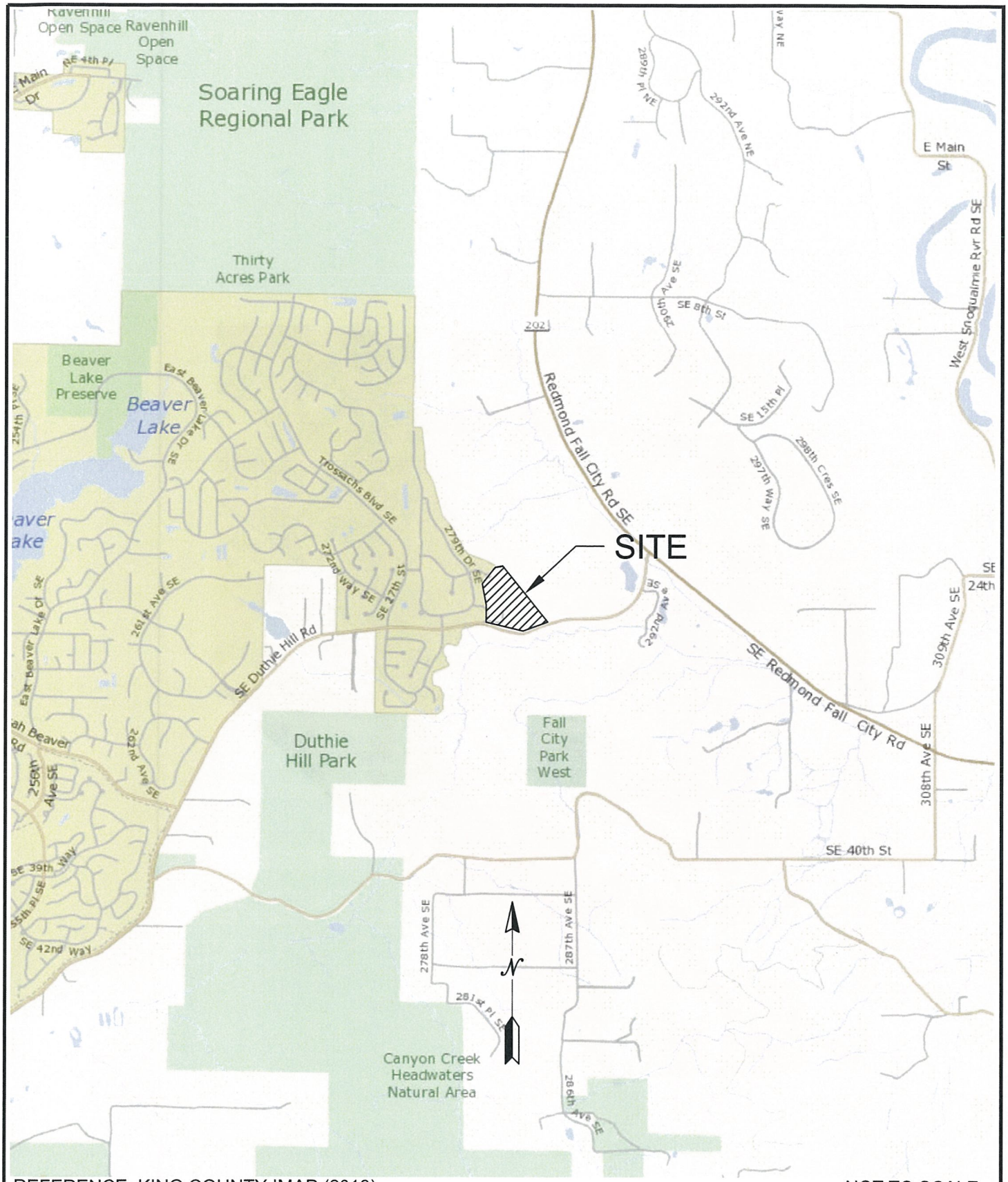
## 5.0 ADDITIONAL SERVICES

Terra Associates, Inc. should review the final designs and specifications in order to verify that earthwork and foundation recommendations have been properly interpreted and implemented in project design. We should also provide geotechnical services during construction in order to observe compliance with our design concepts, specifications, and recommendations. This will allow for design changes if subsurface conditions differ from those anticipated prior to the start of construction.

## 6.0 LIMITATIONS

We prepared this report in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made. This report is the copyrighted property of Terra Associates, Inc. and is intended for specific application to the Aldarra Lot N project in King County, Washington. This report is for the exclusive use of Taconite, LLC and their authorized representatives. No other warranty, expressed or implied, is made.

The analyses and recommendations presented in this report are based on data obtained from the test pits and borings performed at the site. Variations in soil conditions can occur, the nature and extent of which may not become evident until construction. If variations appear evident, Terra Associates, Inc. should be requested to reevaluate the recommendations in this report, prior to proceeding with construction.




REFERENCE: KING COUNTY IMAP (2018)

NOT TO SCALE

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Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

VICINITY MAP
ALDARRA LOT N
KING COUNTY, WASHINGTON

| Proj. No.T-7919 | Date JUN 2018 | Figure 1 |
|---|---|---|


**NOTE:**

THIS SITE PLAN IS SCHEMATIC. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE. IT IS INTENDED FOR REFERENCE ONLY AND SHOULD NOT BE USED FOR DESIGN OR CONSTRUCTION PURPOSES.

**REFERENCE:**

SITE PLAN BY GOLDSMITH

**LEGEND:**

APPROXIMATE TEST PIT LOCATION

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Geology and
Environmental Earth Sciences

EXPLORATION LOCATION PLAN
ALDARRA LOT N
KING COUNTY, WASHINGTON

| Proj. No.T-7919 | Date JUN 2018 | Figure 2 |
|---|---|---|


**NOTE:**

THIS SITE PLAN IS SCHEMATIC. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE. IT IS INTENDED FOR REFERENCE ONLY AND SHOULD NOT BE USED FOR DESIGN OR CONSTRUCTION PURPOSES.

**REFERENCE:**

SITE PLAN BY GOLDSMITH

**LEGEND:**

- APPROXIMATE TEST PIT LOCATION
- APPROXIMATE EROSION HAZARD AREA PER KCC 21A.06.415
- APPROXIMATE STEEP SLOPE HAZARD AREA PER KCC 21A.06.1230
- EXEMPT FROM STEEP SLOPE HAZARD AREAS DEVELOPMENT STANDARDS PER KCC 21A.24.310.D.1
- A — A' GEOLOGIC SECTION A-A'

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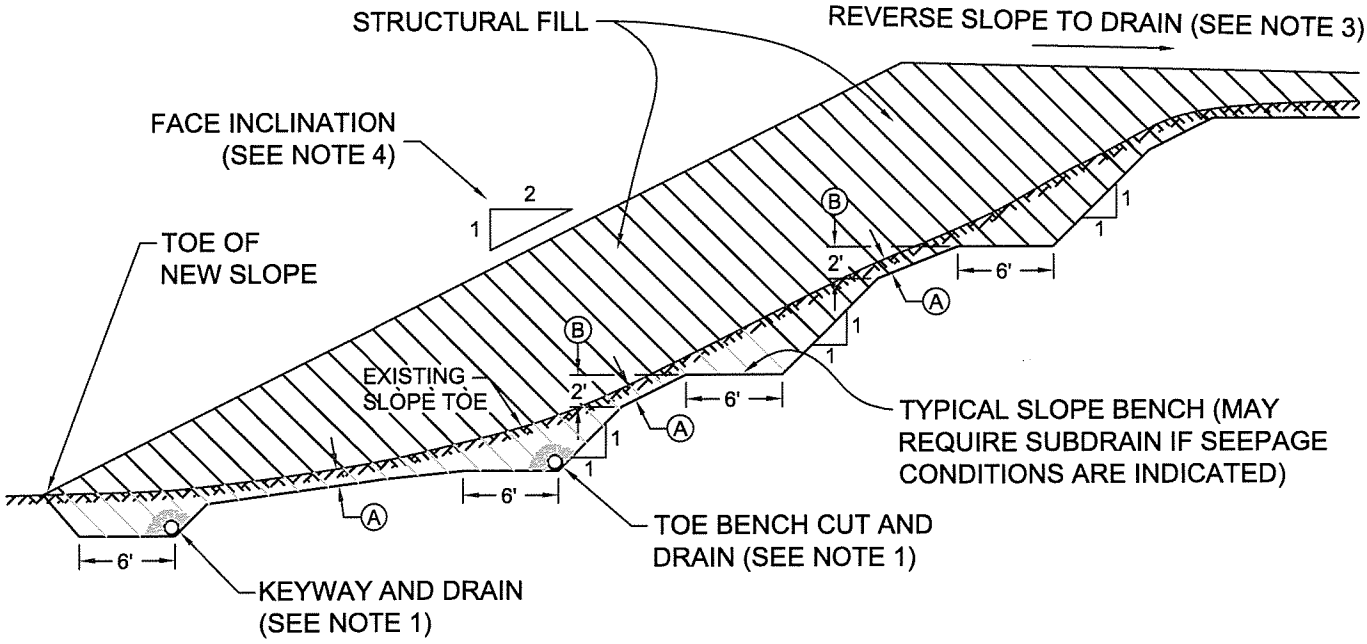
Geology and
Environmental Earth Sciences

# GEOLOGIC HAZARD AREAS MAP
# ALDARRA LOT N
# KING COUNTY, WASHINGTON

| Proj. No.T-7919 | Date JUN 2018 | Figure 3 |
|---|---|---|




## NOT TO SCALE

**NOTES:**

1) DRAINS SHALL CONSIST OF 6" DIAMETER PERFORATED PVC PIPE ENVELOPED IN 1 cu. ft. OF WASHED 3/4" MINUS DRAINAGE GRAVEL.

2) (A) – TOPSOIL REMOVAL THICKNESS BETWEEN KEYWAY AND BENCHES.

   (B) – VERTICAL ELEVATION DIFFERENCE BETWEEN TOP OF LOWER BENCH BACKCUT AND UPPER BENCH ELEVATION.

3) RECOMMENDED PRIOR TO ESTABLISHMENT OF PERMANENT EROSION CONTROL MEASURES AND SITE DRAINAGE.

4) PERMANENT FACE INCLINATION TO BE ESTABLISHED AT 2:1 (H:V) OR AS RECOMMENDED BY THE GEOTECHNICAL ENGINEER

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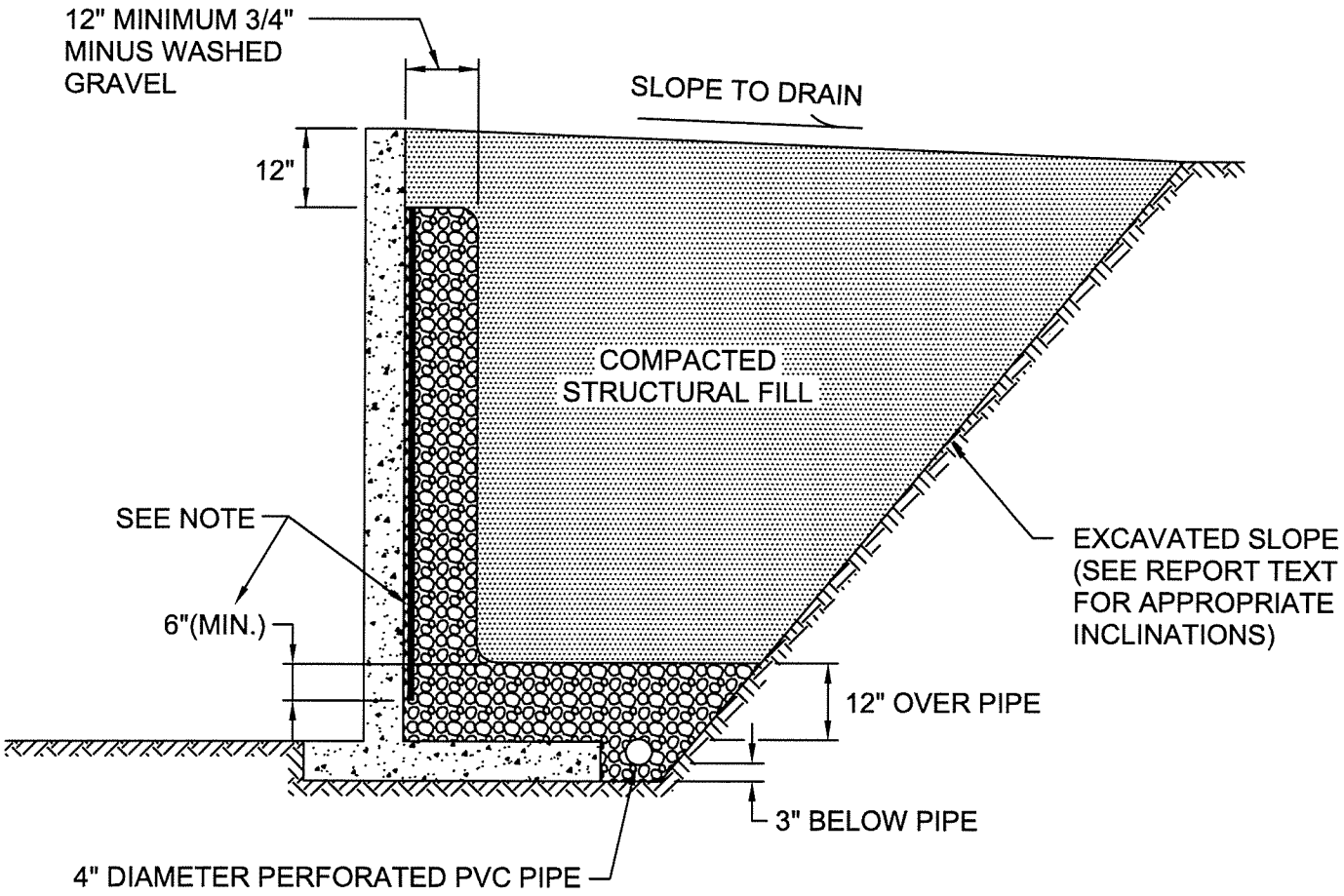
Environmental Earth Sciences

GENERALIZED SLOPE FILL DETAIL
ALDARRA LOT N
KING COUNTY, WASHINGTON

| Proj. No.T-7919 | Date JUN 2018 | Figure 4 |
|---|---|---|




**NOT TO SCALE**

## NOTE:

MIRADRAIN G100N PREFABRICATED DRAINAGE PANELS OR SIMILAR PRODUCT CAN BE SUBSTITUTED FOR THE 12-INCH WIDE GRAVEL DRAIN BEHIND WALL. DRAINAGE PANELS SHOULD EXTEND A MINIMUM OF 6 INCHES INTO 12-INCH THICK DRAINAGE GRAVEL LAYER OVER PERFORATED DRAIN PIPE.

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Geology and
Environmental Earth Sciences

TYPICAL WALL DRAINAGE DETAIL
ALDARRA LOT N
KING COUNTY, WASHINGTON

| Proj. No.T-7919 | Date JUN 2018 | Figure 5 |
|---|---|---|

## APPENDIX A

## FIELD EXPLORATION AND LABORATORY TESTING

**Aldarra Lot N**
**King County, Washington**

We explored subsurface conditions at the site in 18 test pits excavated to depths about 9 to 15 feet below ground surface using a track-mounted excavator. The test pit locations are shown on Figure 2. The test pit locations were approximately determined in the field by sighting and pacing relative to existing surface features. The Test Pit Logs are presented as Figures A-2 through A-19.

An engineering geologist from our office conducted the field reconnaissance and subsurface exploration, classified the observed soils, maintained a log of each test pit, obtained representative soil samples, and performed a visual reconnaissance of the site. All soil samples were visually classified in accordance with the Unified Soil Classification System (USCS) described on Figure A-1.

Representative soil samples obtained from the test pits were placed in sealed containers and taken to our laboratory for further examination and testing. The moisture content of each sample was measured and is reported on the Test Pit Logs. Grain size analyses were performed on 11 soil samples. The test results are shown on Figures A-20 through A-23.

| MAJOR DIVISIONS | | | LETTER SYMBOL | TYPICAL DESCRIPTION |
|---|---|---|---|---|
| COARSE GRAINED SOILS More than 50% material larger than No. 200 sieve size | **GRAVELS** More than 50% of coarse fraction is larger than No. 4 sieve | Clean Gravels (less than 5% fines) | GW | Well-graded gravels, gravel-sand mixtures, little or no fines. |
| | | | GP | Poorly-graded gravels, gravel-sand mixtures, little or no fines. |
| | | Gravels with fines | GM | Silty gravels, gravel-sand-silt mixtures, non-plastic fines. |
| | | | GC | Clayey gravels, gravel-sand-clay mixtures, plastic fines. |
| | **SANDS** More than 50% of coarse fraction is smaller than No. 4 sieve | Clean Sands (less than 5% fines) | SW | Well-graded sands, sands with gravel, little or no fines. |
| | | | SP | Poorly-graded sands, sands with gravel, little or no fines. |
| | | Sands with fines | SM | Silty sands, sand-silt mixtures, non-plastic fines. |
| | | | SC | Clayey sands, sand-clay mixtures, plastic fines. |
| FINE GRAINED SOILS More than 50% material smaller than No. 200 sieve size | **SILTS AND CLAYS** Liquid Limit is less than 50% | | ML | Inorganic silts, rock flour, clayey silts with slight plasticity. |
| | | | CL | Inorganic clays of low to medium plasticity. (Lean clay) |
| | | | OL | Organic silts and organic clays of low plasticity. |
| | **SILTS AND CLAYS** Liquid Limit is greater than 50% | | MH | Inorganic silts, elastic. |
| | | | CH | Inorganic clays of high plasticity. (Fat clay) |
| | | | OH | Organic clays of high plasticity. |
| HIGHLY ORGANIC SOILS | | | PT | Peat. |

## DEFINITION OF TERMS AND SYMBOLS

**COHESIONLESS**

| Density | Standard Penetration Resistance in Blows/Foot |
|---|---|
| Very Loose | 0-4 |
| Loose | 4-10 |
| Medium Dense | 10-30 |
| Dense | 30-50 |
| Very Dense | >50 |

**COHESIVE**

| Consistancy | Standard Penetration Resistance in Blows/Foot |
|---|---|
| Very Soft | 0-2 |
| Soft | 2-4 |
| Medium Stiff | 4-8 |
| Stiff | 8-16 |
| Very Stiff | 16-32 |
| Hard | >32 |

| | |
|---|---|
| I | 2" OUTSIDE DIAMETER SPILT SPOON SAMPLER |
| ‖ | 2.4" INSIDE DIAMETER RING SAMPLER OR SHELBY TUBE SAMPLER |
| ▼ | WATER LEVEL (Date) |
| Tr | TORVANE READINGS, tsf |
| Pp | PENETROMETER READING, tsf |
| DD | DRY DENSITY, pounds per cubic foot |
| LL | LIQUID LIMIT, percent |
| PI | PLASTIC INDEX |
| N | STANDARD PENETRATION, blows per foot |

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UNIFIED SOIL CLASSIFICATION SYSTEM
ALDARRA LOT N
KING COUNTY, WASHINGTON

| Proj. No.T-7919 | Date JUN 2018 | Figure A-1 |
|---|---|---|

# LOG OF TEST PIT NO. 1

FIGURE A-2

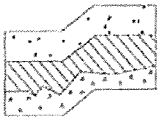
**PROJECT NAME:** Aldarra Lot N **PROJ. NO:** T-7919 **LOGGED BY:** JCS

**LOCATION:** King County, Washington **SURFACE CONDITIONS:** Grasses **APPROX. ELEV:** 278

**DATE LOGGED:** May 17, 2018 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

| Depth (ft) | Sample No. | Description | Consistency/ Relative Density | W (%) |
|---|---|---|---|---|
| 0 | | 12 inches Sod and Topsoil. | | |
| 1 | | Red-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, scattered fine roots. (SM) | Medium Dense | |
| 2 | 1 | Tan silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, strongly cemented, trace of cobbles. (SM) (Till like) | | 16.4 |
| 3 | | | | |
| 4 | | Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, moderately cemented, scattered cobbles. (SM) | Dense to Very Dense | |
| 5 | | | | |
| 6 | | | | |
| 7 | | Gray silty SAND with gravel grading to SAND with silt and gravel, fine to medium sand, fine to coarse gravel, moist, weakly cemented. (SM/SP-SM) | | |
| 8 | | | Dense | |
| 9 | | | | |
| 10 | 2 | Test pit terminated at 10 feet. No groundwater seepage. | | 12.2 |
| 11 | | | | |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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# LOG OF TEST PIT NO. 2

FIGURE A-3

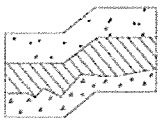
**PROJECT NAME:** Aldarra Lot N **PROJ. NO:** T-7919 **LOGGED BY:** JCS

**LOCATION:** King County, Washington **SURFACE CONDITIONS:** Grasses **APPROX. ELEV:** 280

**DATE LOGGED:** May 17, 2018 **DEPTH TO GROUNDWATER:** 7 ft **DEPTH TO CAVING:** NA

| Depth (ft) | Sample No. | Description | Consistency/ Relative Density | W (%) |
|---|---|---|---|---|
| 0 | | 12 inches Sod and Topsoil. | | |
| 1 | | Tan SILT with sand, fine grained, moist, mottled, slightly plastic. (ML) | | |
| 2 | 1 | | | 28.5 |
| 3 | | | | |
| 4 | | Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist. (SM) | | |
| 5 | | | Dense | |
| 6 | | Gray to gray-brown SAND with silt to SAND with silt and gravel, fine to medium sand, fine to coarse gravel, moist (locally wet). (SP-SM) | | |
| ▼ 7 | | | | |
| 8 | 2 | | | 10.6 |
| 9 | | | | |
| 10 | | Test pit terminated at 15 feet. | | |
| 11 | | Light groundwater seepage from point source at approximately 7 feet. | | |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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# LOG OF TEST PIT NO. 3

FIGURE A-4

**PROJECT NAME:** Aldarra Lot N **PROJ. NO:** T-7919 **LOGGED BY:** JCS

**LOCATION:** King County, Washington **SURFACE CONDITIONS:** Grasses **APPROX. ELEV:** 322

**DATE LOGGED:** May 17, 2018 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

| Depth (ft) | Sample No. | Description | Consistency/ Relative Density | W (%) |
|---|---|---|---|---|
| 0–6 | 1 | 6 inches Sod and Topsoil.<br>Tan to gray-brown, slightly clayey, sandy SILT, fine sand, trace of fine gravel, moist, scattered iron-oxide stained pockets and fractures. (ML) | Dense | 18.6 |
| 6–10 | 2 | Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, moderately to strongly cemented, scattered cobbles. (SM) (Till) | Very Dense | 6.8 |
| 10–12 | 3 | Gray to gray-brown SAND with gravel to SAND with silt and gravel, fine to medium sand, fine to coarse gravel, moist. (SP/SP-SM) | Dense | 5.4 |
| 12–15 | | Test pit terminated at 12 feet.<br>No groundwater seepage. | | |

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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# LOG OF TEST PIT NO. 4

FIGURE A-5

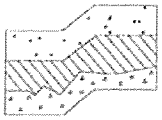
**PROJECT NAME:** Aldarra Lot N **PROJ. NO:** T-7919 **LOGGED BY:** JCS

**LOCATION:** King County, Washington **SURFACE CONDITIONS:** Grasses **APPROX. ELEV:** 278

**DATE LOGGED:** May 17, 2018 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

| Depth (ft) | Sample No. | Description | Consistency/ Relative Density | W (%) |
|---|---|---|---|---|
| 0–1 | | 6 inches Sod and Topsoil.<br>Red-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist. (SM) | Medium Dense | |
| 2–5 | | Gray, brown, and gray-brown, trace to slightly clayey, sandy SILT, fine sand, trace of fine to coarse gravel, moist, mottled. (ML) | Dense | |
| 5–7 | | Gray-brown sandy SILT to sandy SILT with gravel, fine sand, fine to coarse gravel, moist. (ML) | | |
| 7–10 | | Gray-brown sandy SILT with gravel, fine sand, fine to coarse gravel, moist, trace of cobbles, 1.5-foot diameter boulder at 10 feet. (ML) | | |
| 10–15 | | Test pit terminated at 10 feet.<br>No groundwater seepage. | | |

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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# LOG OF TEST PIT NO. 5

FIGURE A-6

**PROJECT NAME:** Aldarra Lot N **PROJ. NO:** T-7919 **LOGGED BY:** JCS

**LOCATION:** King County, Washington **SURFACE CONDITIONS:** Grasses **APPROX. ELEV:** 242

**DATE LOGGED:** May 17, 2018 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

| Depth (ft) | Sample No. | Description | Consistency/ Relative Density | W (%) |
|---|---|---|---|---|
| 0–3 | | 6 inches Sod and Topsoil.<br>FILL: Brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, scattered cobbles and wood debris, 2-foot diameter boulder. (SM) | Medium Dense | |
| 3–6 | 1 | Gray-brown to brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, moderately cemented, mottled, scattered cobbles. (SM) | Dense | 9.9 |
| 6–11 | | Dark gray-brown SAND with silt and gravel to silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, weakly to moderately cemented, scattered cobbles. (SP-SM/SM) | Dense to Very Dense | |
| 11 | 2 | Test pit terminated at 11 feet.<br>No groundwater seepage. | | 6.7 |
| 12–15 | | | | |

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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# LOG OF TEST PIT NO. 6

FIGURE A-7

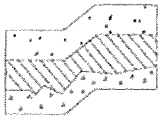
**PROJECT NAME:** Aldarra Lot N **PROJ. NO:** T-7919 **LOGGED BY:** JCS

**LOCATION:** King County, Washington **SURFACE CONDITIONS:** Grasses **APPROX. ELEV:** 250

**DATE LOGGED:** May 17, 2018 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

| Depth (ft) | Sample No. | Description | Consistency/ Relative Density | W (%) |
|---|---|---|---|---|
| 0 | | 6 inches Sod and Topsoil. | | |
| 1 | | Brown to gray-brown sandy SILT with gravel, fine to medium sand, fine to coarse gravel, moist, non-plastic to slightly plastic, mottled above 5 feet. (ML) | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | 1 | | Dense | 18.1 |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | Dark gray SAND with silt and gravel, fine to medium sand, fine to coarse gravel, moist, trace of cobbles. (SP-SM) | | |
| 11 | 2 | | | 6.8 |
| | | Test pit terminated at 11 feet.<br>No groundwater seepage. | | |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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# LOG OF TEST PIT NO. 7

FIGURE A-8

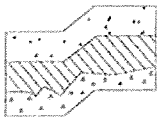
**PROJECT NAME:** Aldarra Lot N **PROJ. NO:** T-7919 **LOGGED BY:** JCS

**LOCATION:** King County, Washington **SURFACE CONDITIONS:** Grasses **APPROX. ELEV:** 262

**DATE LOGGED:** May 17, 2018 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

| Depth (ft) | Sample No. | Description | Consistency/ Relative Density | W (%) |
|---|---|---|---|---|
| 0 | | 6 inches Sod and Topsoil. | | |
| 1 | | Red-brown silty SAND with gravel to sandy SILT with gravel, fine sand, fine to coarse gravel, moist. (SM/ML) | Medium Dense | |
| 2 | | Gray and light gray-brown to tan sandy SILT with gravel, fine sand, fine to coarse gravel, moist, non-plastic to slightly plastic, mottled above 5 feet. (ML) | | |
| 3 | | | | |
| 4 | | | | |
| 5 | 1 | | | 32.9 |
| 6 | | | | |
| 7 | | Dark gray to gray-brown SAND with silt and gravel to silty SAND with gravel, moist, scattered cobbles and cemented till-like zones. (SP-SM/SM) | Dense to Very Dense | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |
| 11 | | | | |
| 12 | | - Partially exposed boulder at 13 feet. | | |
| 13 | 2 | | | 6.2 |
| | | Test pit terminated at 13 feet.<br>No groundwater seepage. | | |
| 14 | | | | |
| 15 | | | | |

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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# LOG OF TEST PIT NO. 8

FIGURE A-9

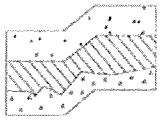
**PROJECT NAME:** Aldarra Lot N **PROJ. NO:** T-7919 **LOGGED BY:** JCS

**LOCATION:** King County, Washington **SURFACE CONDITIONS:** Grasses **APPROX. ELEV:** 292

**DATE LOGGED:** May 17, 2018 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

| Depth (ft) | Sample No. | Description | Consistency/ Relative Density | W (%) |
|---|---|---|---|---|
| 0 | | 6 inches Sod and Topsoil. | | |
| 1 | | Tan to light brown sandy SILT with gravel, fine sand, fine to medium sand, fine to coarse gravel, moist, mottled. (ML) | Medium Dense | |
| 2 | | | | |
| 3 | 1 | Dark gray to gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, moderately to strongly cemented, scattered cobbles. (SM) (Tilll like) | | 8.7 |
| 4 | | | | |
| 5 | | | | |
| 6 | | | Very Dense | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | 2 | | | 6.9 |
| | | Test pit terminated at 10 feet.<br>No groundwater seepage. | | |
| 11 | | | | |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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# LOG OF TEST PIT NO. 9

FIGURE A-10

**PROJECT NAME:** Aldarra Lot N **PROJ. NO:** T-7919 **LOGGED BY:** JCS

**LOCATION:** King County, Washington **SURFACE CONDITIONS:** Grasses **APPROX. ELEV:** 270

**DATE LOGGED:** May 17, 2018 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

| Depth (ft) | Sample No. | Description | Consistency/ Relative Density | W (%) |
|---|---|---|---|---|
| 0 | | 4 inches Sod and Topsoil. | | |
| 1 | | Light rusty brown sandy SILT with gravel, fine sand, fine to coarse gravel, moist, scattered roots. (ML) | Medium Dense | |
| 2 | | Light gray-brown sandy SILT with gravel, fine to medium sand, fine to coarse gravel, moist, mottled, slightly plastic to non-plastic, trace of cobbles, 2-foot diameter boulder at about 3 feet. (ML) | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | 1 | | Dense | 18.2 |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | Test pit terminated at 10 feet.<br>No groundwater seepage. | | |
| 11 | | | | |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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# LOG OF TEST PIT NO. 10

FIGURE A-11

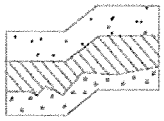
**PROJECT NAME:** Aldarra Lot N **PROJ. NO:** T-7919 **LOGGED BY:** JCS

**LOCATION:** King County, Washington **SURFACE CONDITIONS:** Brush **APPROX. ELEV:** 270

**DATE LOGGED:** May 17, 2018 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

| Depth (ft) | Sample No. | Description | Consistency/ Relative Density | W (%) |
|---|---|---|---|---|
| 0 | | 10 inches Duff and Topsoil. | | |
| 1 | | Light brown GRAVEL with silt and sand, fine to coarse gravel, fine to medium sand, moist. (GP-GM) | Medium Dense to Dense | |
| 2 | | | | |
| 3 | | | | |
| 4 | 1 | | | 31.7 |
| 5 | | Gray-brown to tan SILT with sand and gravel to sandy SILT with gravel, fine to medium sand, fine to coarse gravel, moist, mottled. (ML) | | |
| 6 | | | | |
| 7 | | | Dense | |
| 8 | | | | |
| 9 | 2 | Gray to gray-brown SAND with silt and gravel, fine to medium sand, fine to coarse gravel, moist, weakly cemented, trace of cobbles. (SP-SM) | | 9.4 |
| 10 | | Test pit terminated at 10 feet. No groundwater seepage. | | |
| 11 | | | | |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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# LOG OF TEST PIT NO. 11

FIGURE A-12

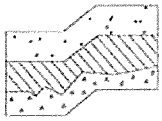
**PROJECT NAME:** Aldarra Lot N **PROJ. NO:** T-7919 **LOGGED BY:** JCS

**LOCATION:** King County, Washington **SURFACE CONDITIONS:** Grasses **APPROX. ELEV:** 334

**DATE LOGGED:** May 17, 2018 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

| Depth (ft) | Sample No. | Description | Consistency/ Relative Density | W (%) |
|---|---|---|---|---|
| 0 | | 6 inches Sod and Topsoil. | | |
| 1 | | Red-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, scattered cobbles. (SM) | Medium Dense | |
| 2 | 1 | | | 11.7 |
| 3 | | Gray silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, moderately cemented, scattered cobbles. (SM) (Till) | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | Very Dense | |
| 7 | | | | |
| 8 | | | | |
| 9 | 2 | | | 9.4 |
| 10 | | Test pit terminated at 10 feet. No groundwater seepage. | | |
| 11 | | | | |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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# LOG OF TEST PIT NO. 12

FIGURE A-13

**PROJECT NAME:** Aldarra Lot N **PROJ. NO:** T-7919 **LOGGED BY:** JCS

**LOCATION:** King County, Washington **SURFACE CONDITIONS:** Grasses **APPROX. ELEV:** 305

**DATE LOGGED:** May 17, 2018 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

| Depth (ft) | Sample No. | Description | Consistency/ Relative Density | W (%) |
|---|---|---|---|---|
| 0–1 | | 8 inches Sod and Topsoil.<br>Red-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, scattered roots. (SM) | Medium Dense | |
| 2–4 | 1 | Brown to gray-brown SAND with gravel to SAND with silt and gravel, fine to medium sand, fine to coarse gravel, moist. (SP/SP-SM) | Dense | 11.3 |
| 5–7 | 2 | Gray SAND with silt and gravel to silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, weakly to moderately cemented, scattered strongly-cemented till-like zones intercalated with moist to wet sand with gravel. (SP-SM/SM) | Dense to Very Dense | 9.0 |
| 9–15 | | Test pit terminated at 9 feet.<br>No groundwater seepage. | | |

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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# LOG OF TEST PIT NO. 13

FIGURE A-14

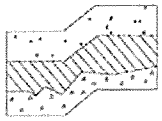
**PROJECT NAME:** Aldarra Lot N **PROJ. NO:** T-7919 **LOGGED BY:** JCS

**LOCATION:** King County, Washington **SURFACE CONDITIONS:** Grasses **APPROX. ELEV:** 310

**DATE LOGGED:** May 17, 2018 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

| Depth (ft) | Sample No. | Description | Consistency/ Relative Density | W (%) |
|---|---|---|---|---|
| 0 | | 8 inches Sod and Topsoil. | | |
| 1 | | Gray-brown SILT with sand and gravel to sandy SILT with gravel, fine to medium sand, fine to coarse gravel, moist, trace of cobbles. (ML) | | |
| 2 | | | | |
| 3 | 1 | | | 23.8 |
| 4 | | | | |
| 5 | | | Dense | |
| 6 | | | | |
| 7 | | Gray-brown SAND, fine grained, moist. (SP) | | |
| 8 | 2 | | | 25.2 |
| 9 | | Gray-brown sandy SILT with gravel to silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, weakly cemented, scattered cobbles, scattered boulders to 1.5 feet in diameter. (ML/SM) | Dense to Very Dense | |
| 10 | | Test pit terminated at 10 feet. | | |
| 11 | | No groundwater seepage. | | |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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# LOG OF TEST PIT NO. 14

FIGURE A-15

**PROJECT NAME:** Aldarra Lot N **PROJ. NO:** T-7919 **LOGGED BY:** JCS

**LOCATION:** King County, Washington **SURFACE CONDITIONS:** Grasses **APPROX. ELEV:** 320

**DATE LOGGED:** May 17, 2018 **DEPTH TO GROUNDWATER:** 7 ft **DEPTH TO CAVING:** NA

| Depth (ft) | Sample No. | Description | Consistency/ Relative Density | W (%) |
|---|---|---|---|---|
| 0–5 | 1 | 8 inches Sod and Topsoil.<br>Brown to gray-brown sandy SILT with gravel, fine to medium sand, fine to coarse gravel, moist, mottled, trace of cobbels, 1.5-foot diameter boulder at 3 feet. (ML) | Dense | 16.8 |
| 5–7 | | Gray brown SAND with silt and gravel to silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, scattered cobbles, scattered weakly- to strongly-cemented till-like zones. (SP-SM/SM) | Dense to Very Dense | |
| 7–12 | 2 | Brown SAND with gravel, fine sand, fine to coarse gravel, moist. (SP) | Dense | 14.1 |
| 12 | 3 | Test pit terminated at 12 feet.<br>Light groundwater seepage from point source at 7 feet. | | 10.3 |

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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# LOG OF TEST PIT NO. 15

FIGURE A-16

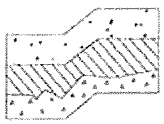
**PROJECT NAME:** Aldarra Lot N **PROJ. NO:** T-7919 **LOGGED BY:** JCS

**LOCATION:** King County, Washington **SURFACE CONDITIONS:** Grasses **APPROX. ELEV:** 342

**DATE LOGGED:** May 17, 2018 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

| Depth (ft) | Sample No. | Description | Consistency/ Relative Density | W (%) |
|---|---|---|---|---|
| 0 | | 8 inches Sod and Topsoil. | | |
| 1 | | Red-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, scattered cobbles, scattered boulders to 1.5 feet in diameter. (SM) | Medium Dense | |
| 2 | | Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, moderately cemented, scattered cobbles. (SM) | | |
| 3 | | | | |
| 4 | 1 | | Dense to Very Dense | 13.3 |
| 5 | | | | |
| 6 | | Gray-brown SAND with silt and gravel, fine to coarse sand, fine to coarse gravel, moist, scattered cobbles. (SP-SM) | | |
| 7 | | | | |
| 8 | | | Dense | |
| 9 | | | | |
| 10 | 2 | | | 6.8 |
| | | Test pit terminated at 10 feet.<br>No groundwater seepage. | | |
| 11 | | | | |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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# LOG OF TEST PIT NO. 16

FIGURE A-17

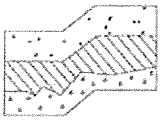
**PROJECT NAME:** Aldarra Lot N **PROJ. NO:** T-7919 **LOGGED BY:** JCS

**LOCATION:** King County, Washington **SURFACE CONDITIONS:** Grasses **APPROX. ELEV:** 360

**DATE LOGGED:** May 17, 2018 **DEPTH TO GROUNDWATER:** 9 ft **DEPTH TO CAVING:** NA

| Depth (ft) | Sample No. | Description | Consistency/ Relative Density | W (%) |
|---|---|---|---|---|
| 0–1 | | 8 inches Sod and Topsoil.<br>Red-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, 1.5-foot diameter boulder, scattered roots. (SM) | Medium Dense | |
| 2–3 | | Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, mottled. (SM) | Dense | |
| 3–9 | 1 | Gray-brown silty SAND with gravel to SAND with silt and gravel, fine to medium sand, fine to coarse gravel, moist, strongly cemented, scattered cobbles. (SM/SP-SM) (Till) | Very Dense | 10.7 |
| ▼9 | 2 | | | 8.9 |
| 10–14 | 3 | Gray to gray-brown SAND with silt and gravel to GRAVEL with silt and sand, fine to medium sand, fine to coarse gravel, moist (locally wet), trace of cobbles. (SP-SM/GP-GM) | Dense | 11.3 |
| 15 | 4 | | | 8.5 |
| 15–17 | | Test pit terminated at 15 feet.<br>Light groundwater seepage from several point sources at 9 feet. | | |

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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# LOG OF TEST PIT NO. 17

FIGURE A-18

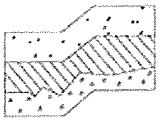
**PROJECT NAME:** Aldarra Lot N **PROJ. NO:** T-7919 **LOGGED BY:** JCS

**LOCATION:** King County, Washington **SURFACE CONDITIONS:** Grasses **APPROX. ELEV:** 346

**DATE LOGGED:** May 17, 2018 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

| Depth (ft) | Sample No. | Description | Consistency/ Relative Density | W (%) |
|---|---|---|---|---|
| 0 | | 10 inches Sod and Topsoil. | | |
| 1 | | Red-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, scattered boulders to 2 feet in diameter. (SM) | Medium Dense | |
| 2 | | | | |
| 3 | | Gray-brown GRAVEL with silt and sand grading to SAND with silt and gravel, fine to coarse gravel, fine to medium sand, moist, numerous cobbles below 6 feet, scattered wet gravel layers. (GP-GM/SP-SM) | | |
| 4 | 1 | | | 5.5 |
| 5 | | | | |
| 6 | | | Dense | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | Test pit terminated at 10 feet.<br>No groundwater seepage. | | |
| 11 | | | | |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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# LOG OF TEST PIT NO. 18

FIGURE A-19

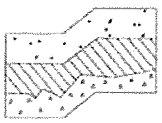
**PROJECT NAME:** Aldarra Lot N **PROJ. NO:** T-7919 **LOGGED BY:** JCS

**LOCATION:** King County, Washington **SURFACE CONDITIONS:** Grasses **APPROX. ELEV:** 346

**DATE LOGGED:** May 17, 2018 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

| Depth (ft) | Sample No. | Description | Consistency/ Relative Density | W (%) |
|---|---|---|---|---|
| 0 | | 6 inches Sod and Topsoil. | | |
| 1 | | Tan to light brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, scattered cobbles. (SM) | Medium Dense | |
| 2 | | | | |
| 3 | | Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, moderately to strongly cemented, scattered cobbles. (SM) (Till) | | |
| 4 | | | | |
| 5 | | | | |
| 6 | 1 | | Very Dense | 8.4 |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | 2 | | | 7.7 |
| | | Test pit terminated at 10 feet.<br>No groundwater seepage. | | |
| 11 | | | | |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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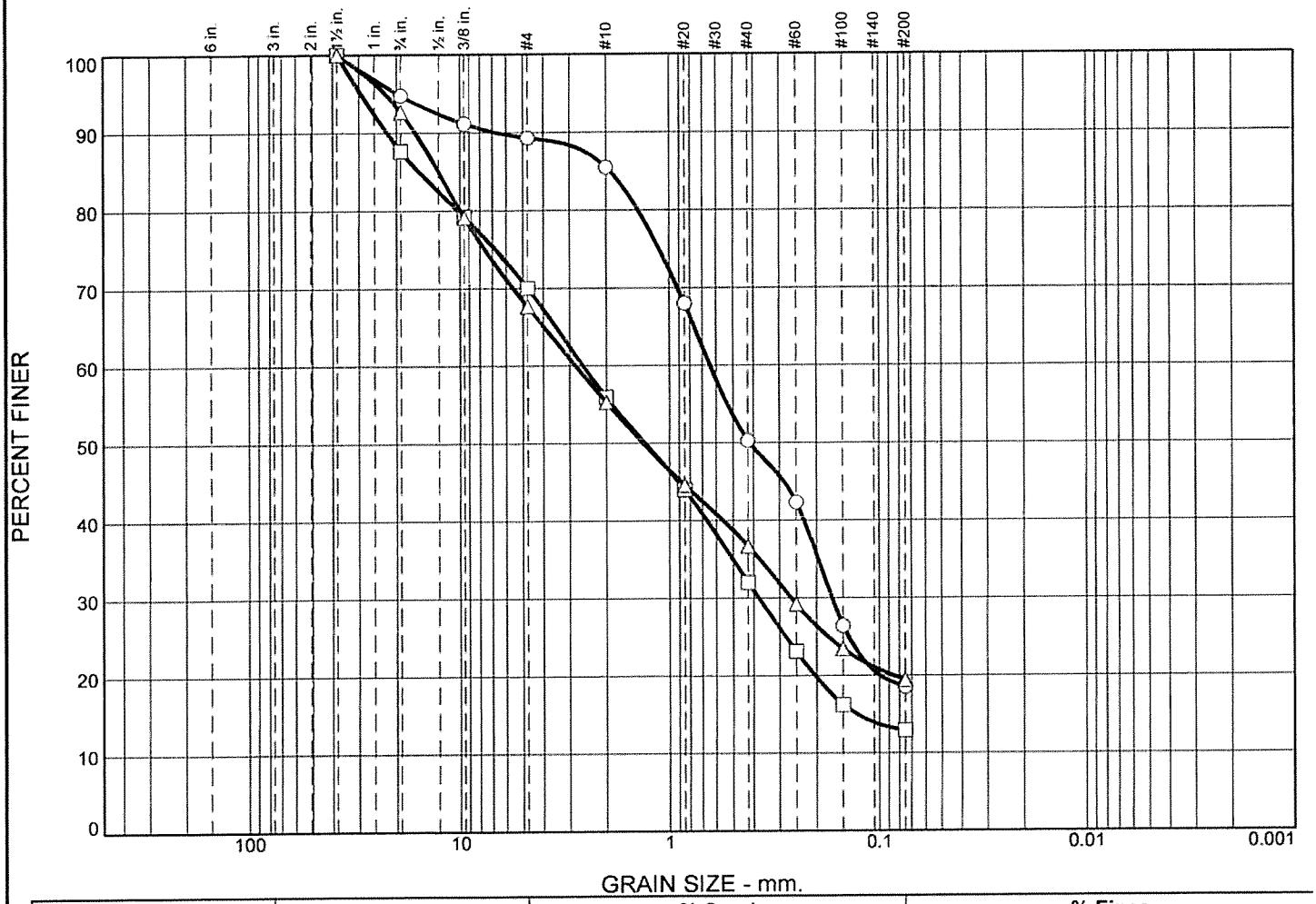
# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 5.3 | 5.4 | 3.8 | 35.2 | 31.8 | 18.5 | |
| □ | 0.0 | 12.4 | 17.6 | 14.1 | 23.9 | 19.1 | 12.9 | |
| △ | 0.0 | 7.4 | 25.0 | 12.3 | 18.6 | 17.3 | 19.4 | |

| | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | | | 1.9175 | 0.6419 | 0.4172 | 0.1694 | | | | |
| □ | | | 15.7457 | 2.5916 | 1.3032 | 0.3790 | 0.1296 | | | |
| △ | | | 12.7295 | 2.8109 | 1.3353 | 0.2649 | | | | |

| Material Description | USCS | AASHTO |
|---|---|---|
| ○ silty SAND | SM | |
| □ silty SAND with gravel | SM | |
| △ silty SAND with gravel | SM | |

**Project No.** T-7919 **Client:** Taconite, LLC

**Project:** Aldarra Lot N

○ **Location:** TP-1 **Depth:** 10'

□ **Location:** TP-5 **Depth:** 4'

△ **Location:** TP-5 **Depth:** 11'

**Remarks:**

○ Tested May 29, 2018

□ Tested May 29, 2018

△ Tested May 29, 2018

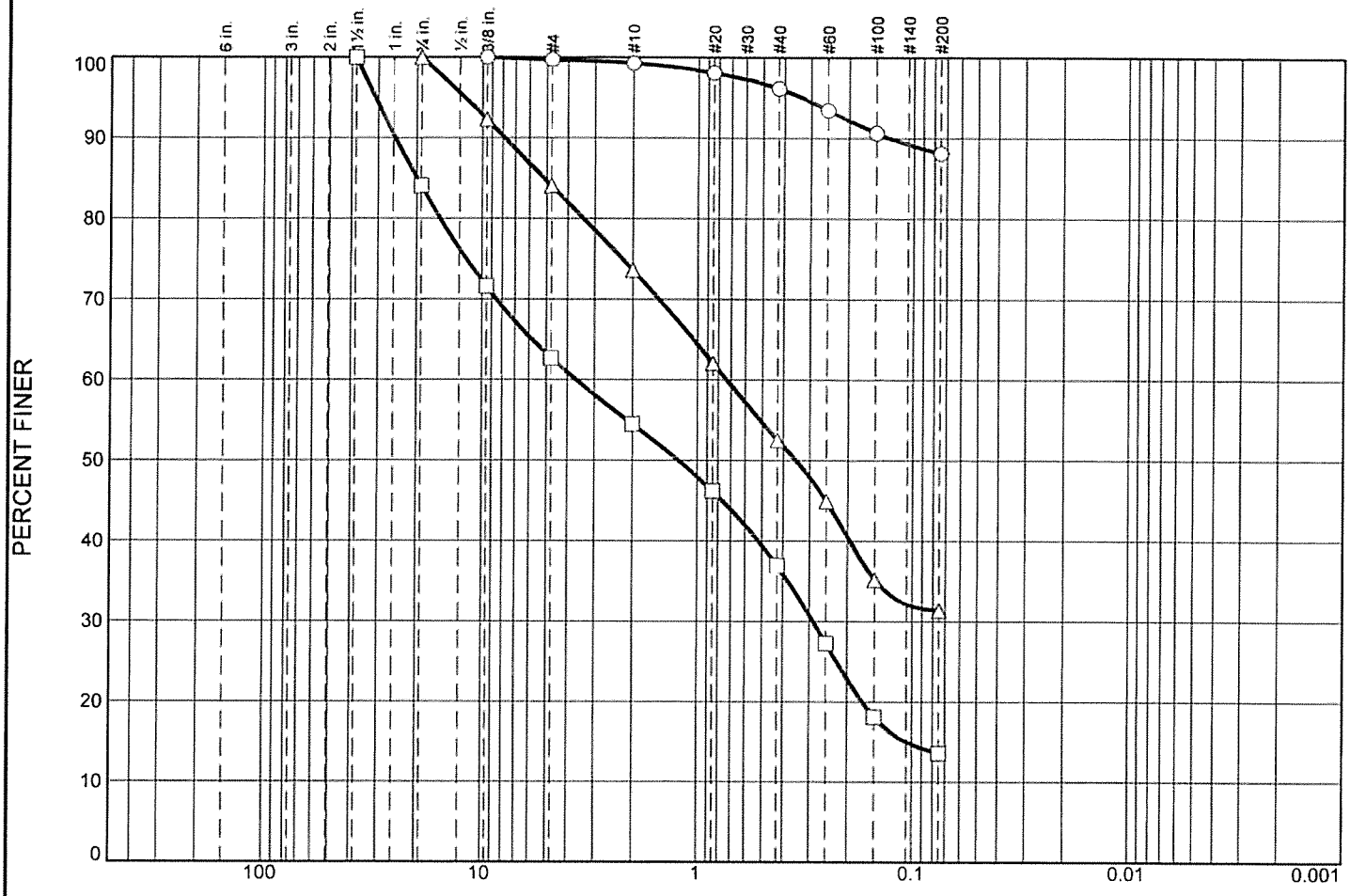
**Terra Associates, Inc.**

**Kirkland, WA**

**Figure** A-20

**Tested By:** FQ

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.3 | 0.4 | 3.2 | 8.0 | 88.1 | |
| □ | 0.0 | 16.0 | 21.3 | 8.2 | 17.6 | 23.3 | 13.6 | |
| △ | 0.0 | 0.0 | 16.0 | 10.4 | 21.1 | 21.1 | 31.4 | |

| | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | | | | | | | | | | |
| □ | | | 19.9730 | 3.6498 | 1.2262 | 0.2887 | 0.1064 | | | |
| △ | | | 5.1636 | 0.7328 | 0.3500 | | | | | |

| Material Description | USCS | AASHTO |
|---|---|---|
| ○ SILT | ML | |
| □ silty SAND with gravel | SM | |
| △ silty SAND with gravel | SM | |

**Project No.** T-7919 **Client:** Taconite, LLC

**Project:** Aldarra Lot N

○ **Location:** TP-7 **Depth:** 5'

□ **Location:** TP-7 **Depth:** 13'

△ **Location:** TP-11 **Depth:** 9'

**Remarks:**

○ Tested May 29, 2018

□ Tested May 29, 2018

△ Tested May 29, 2018

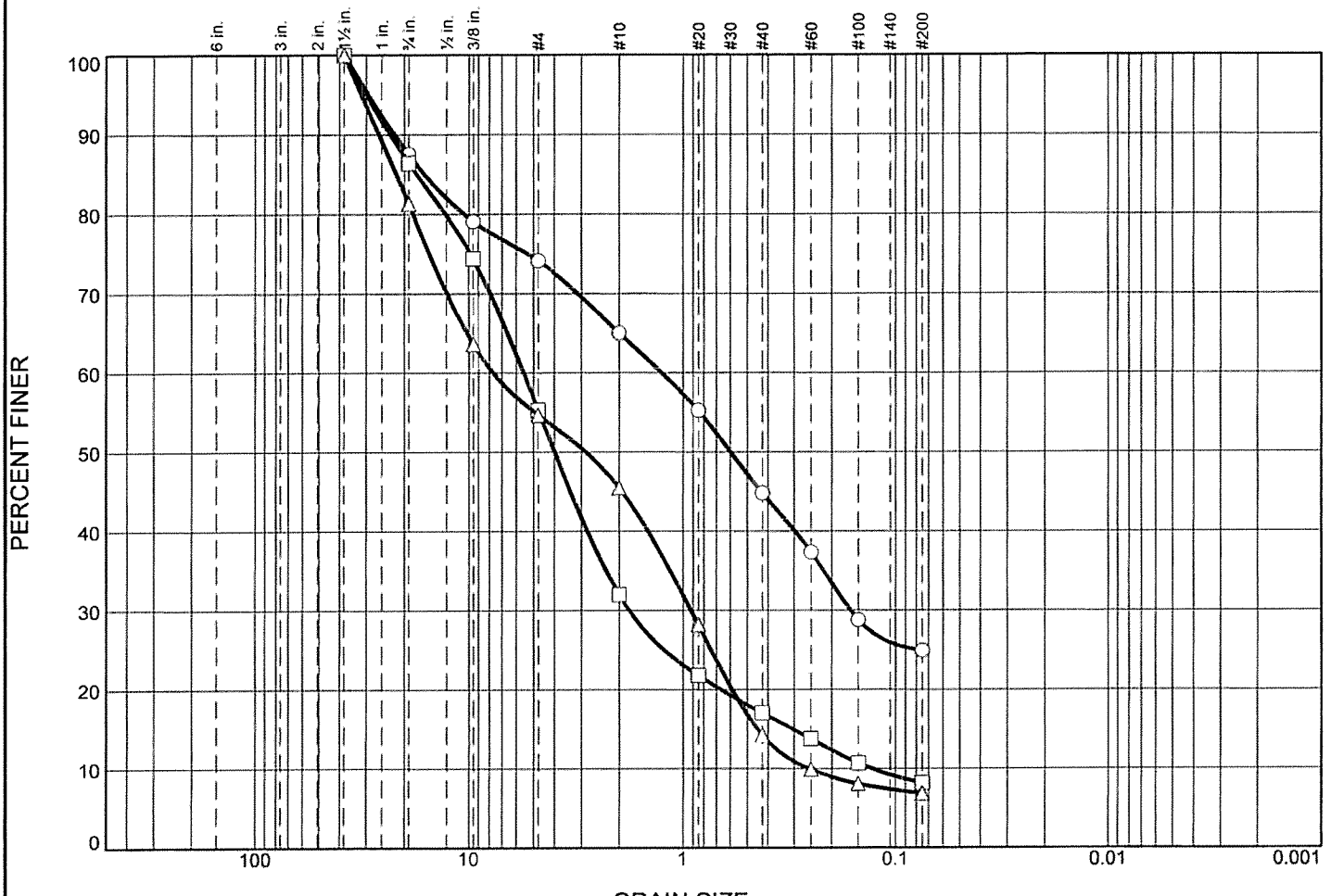
**Terra Associates, Inc.**

**Kirkland, WA**

**Figure** A-21

**Tested By:** FQ

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 12.5 | 13.4 | 9.1 | 20.2 | 19.9 | 24.9 | |
| □ | 0.0 | 13.6 | 31.1 | 23.3 | 15.0 | 8.8 | 8.2 | |
| △ | 0.0 | 18.7 | 26.6 | 9.2 | 31.3 | 7.3 | 6.9 | |

| | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | | | 16.0937 | 1.2579 | 0.5997 | 0.1634 | | | | |
| □ | | | 17.5132 | 5.5480 | 3.9892 | 1.7921 | 0.3046 | 0.1291 | 4.48 | 42.96 |
| △ | | | 21.7804 | 7.6930 | 2.8590 | 0.9190 | 0.4492 | 0.2554 | 0.43 | 30.13 |

| | Material Description | USCS | AASHTO |
|---|---|---|---|
| ○ | silty SAND with gravel | SM | |
| □ | SAND with silt and gravel | SP-SM | |
| △ | SAND with silt and gravel | SP-SM | |

**Project No.** T-7919 **Client:** Taconite, LLC

**Project:** Aldarra Lot N

○ **Location:** TP-15 **Depth:** 4'

□ **Location:** TP-16 **Depth:** 3.5'

△ **Location:** TP-16 **Depth:** 15'

**Remarks:**

○ Tested May 29, 2018

□ Tested May 29, 2018

△ Tested May 29, 2018

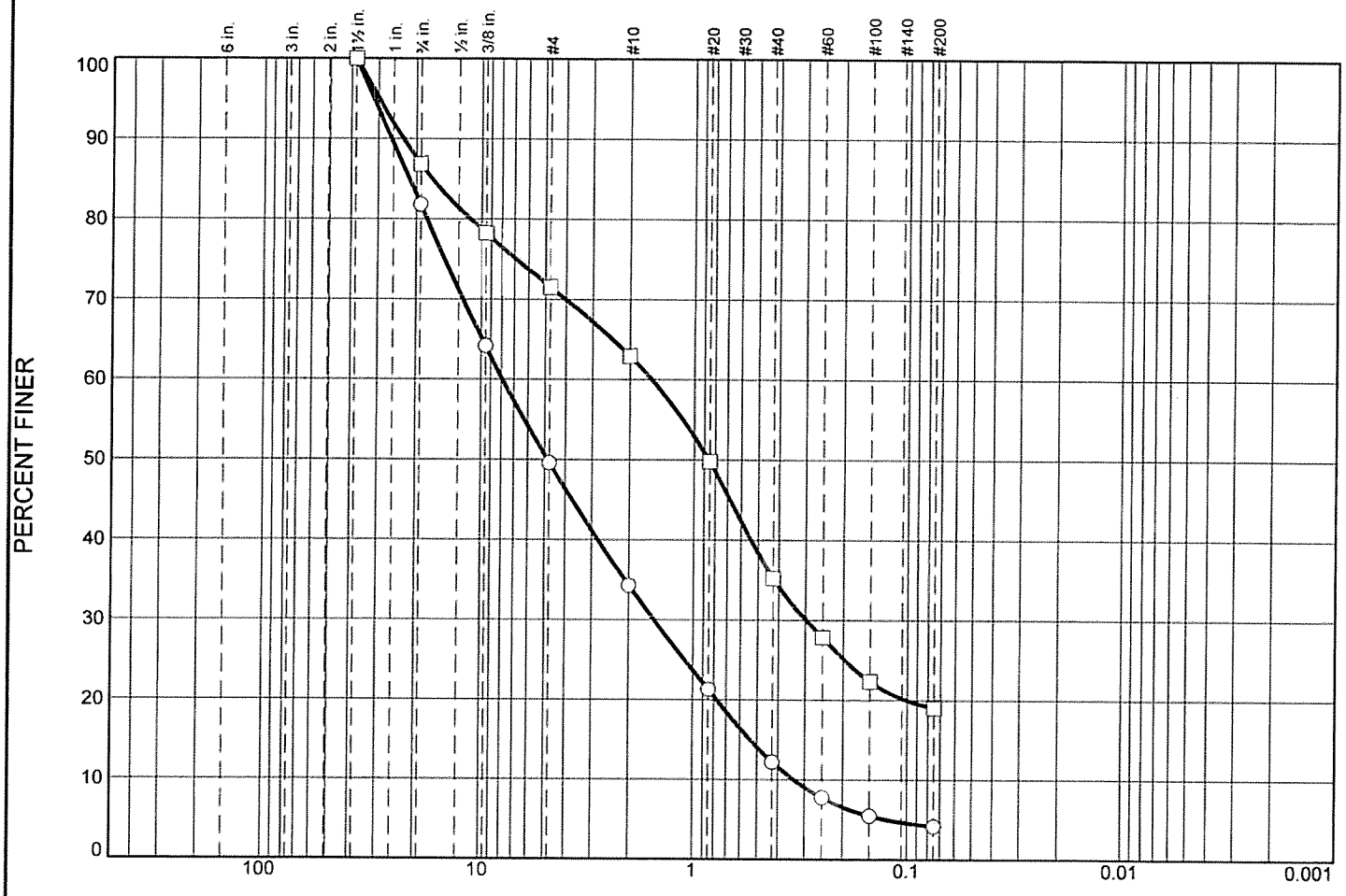
**Terra Associates, Inc.**

**Kirkland, WA**

**Figure** A-22

**Tested By:** FQ

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 18.2 | 32.2 | 15.3 | 22.1 | 8.0 | 4.2 | |
| □ | 0.0 | 13.2 | 15.3 | 8.6 | 27.7 | 16.2 | 19.0 | |

| | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | | | 21.5137 | 7.9126 | 4.8500 | 1.5244 | 0.5391 | 0.3379 | 0.87 | 23.41 |
| □ | | | 16.9072 | 1.5818 | 0.8585 | 0.2991 | | | | |

| Material Description | USCS | AASHTO |
|---|---|---|
| ○ GRAVEL with sand<br>□ silty SAND with gravel | GP-GM<br>SM | |

**Project No.** T-7919 **Client:** Taconite, LLC
**Project:** Aldarra Lot N

○ **Location:** TP-17 **Depth:** 4'
□ **Location:** TP-18 **Depth:** 10'

**Remarks:**
○ Tested May 29, 2018
□ Tested May 29, 2018

**Terra Associates, Inc.**

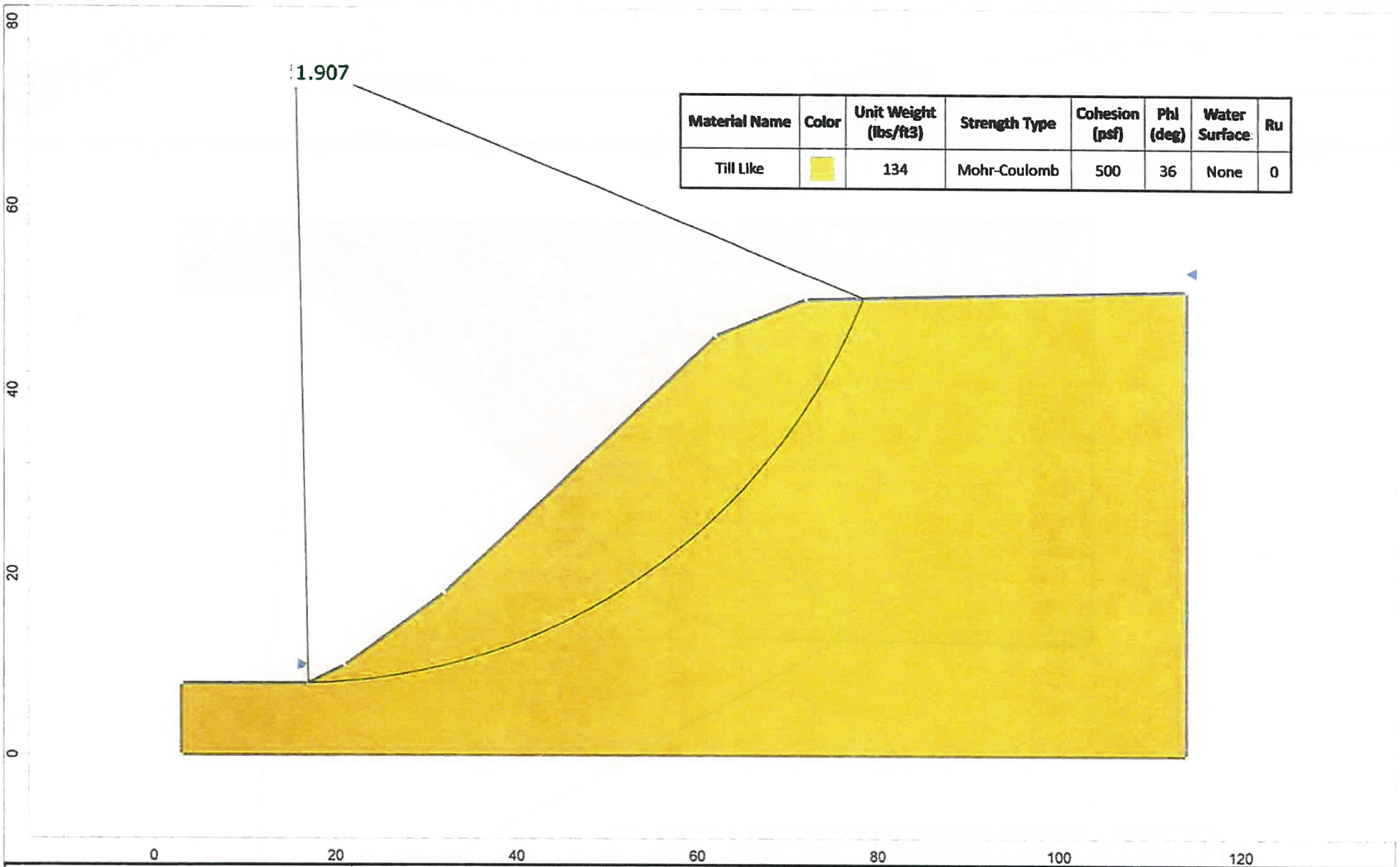
**Kirkland, WA**

**Figure** A-23

**Tested By:** FQ

# APPENDIX B

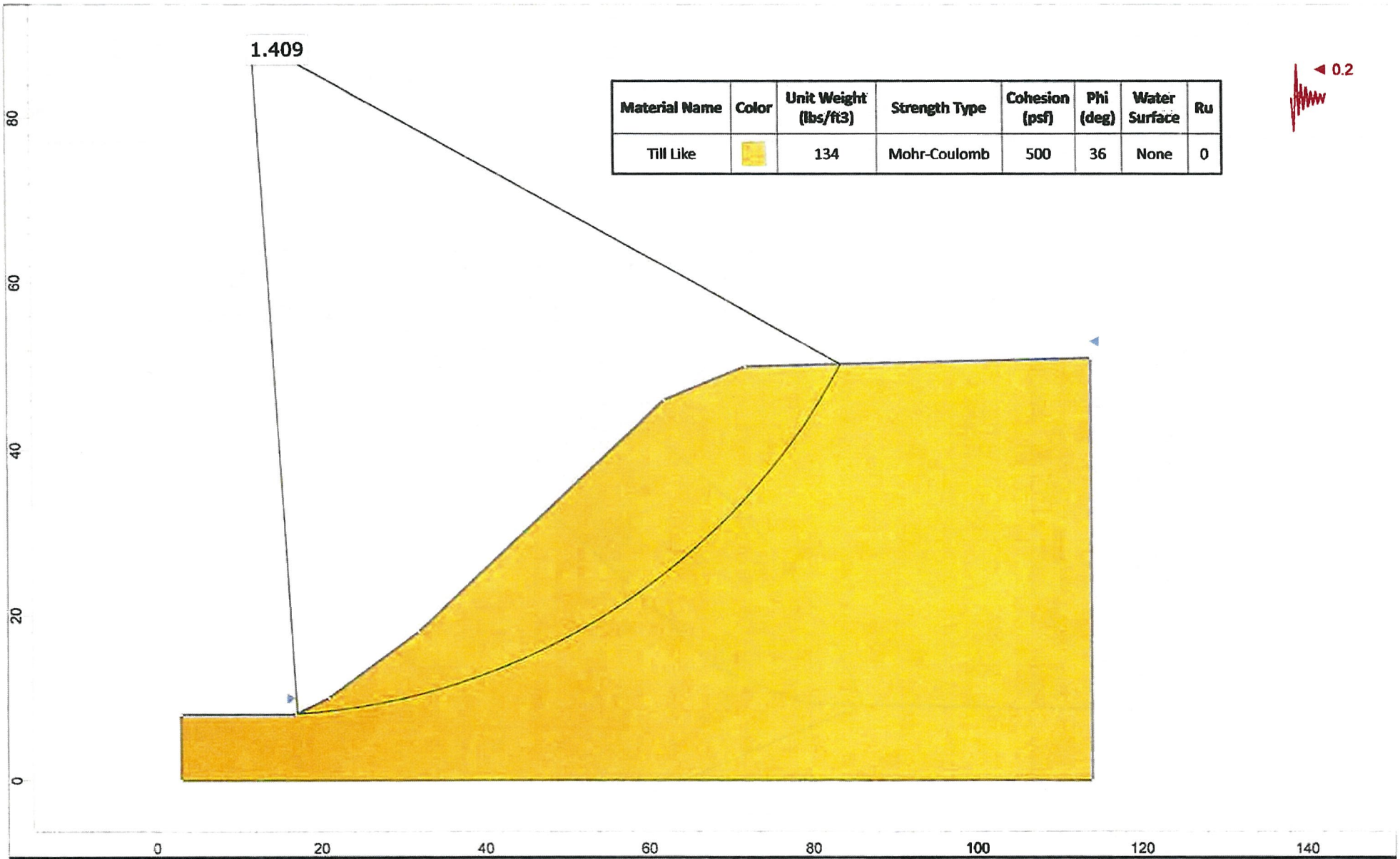
## SLIDE 2018 OUTPUT




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Ru |
|---|---|---|---|---|---|---|---|
| Till Like | | 134 | Mohr-Coulomb | 500 | 36 | None | 0 |

| | | | |
|---|---|---|---|
| rocscience | Project | Aldarra Lot N | |
| | Analysis Description | A-A' Static | |
| | Drawn By | JCS | Company: Terra Associates, Inc. |
| | Date | 6/7/2018 | File Name: A-A.slmd |

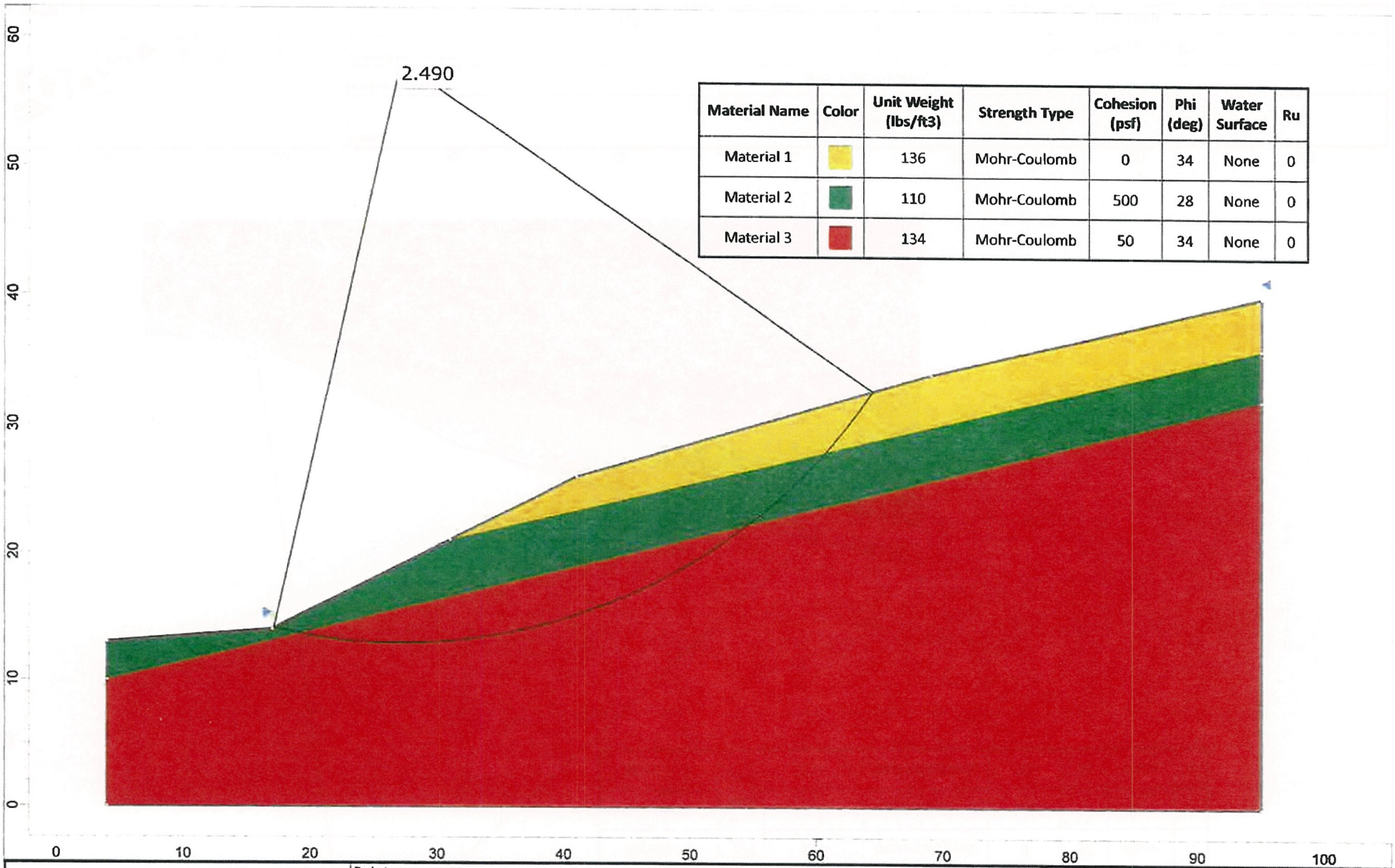
SLIDEINTERPRET 8.008




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Ru |
|---|---|---|---|---|---|---|---|
| Till Like | | 134 | Mohr-Coulomb | 500 | 36 | None | 0 |

| | | | |
|---|---|---|---|
| rocscience | Project | Aldarra Lot N | |
| | Analysis Description | A-A' Pseudostatic | |
| | Drawn By | JCS | Company: Terra Associates, Inc. |
| | Date | 6/7/2018 | File Name: A-A.slmd |

SLIDEINTERPRET 8.005

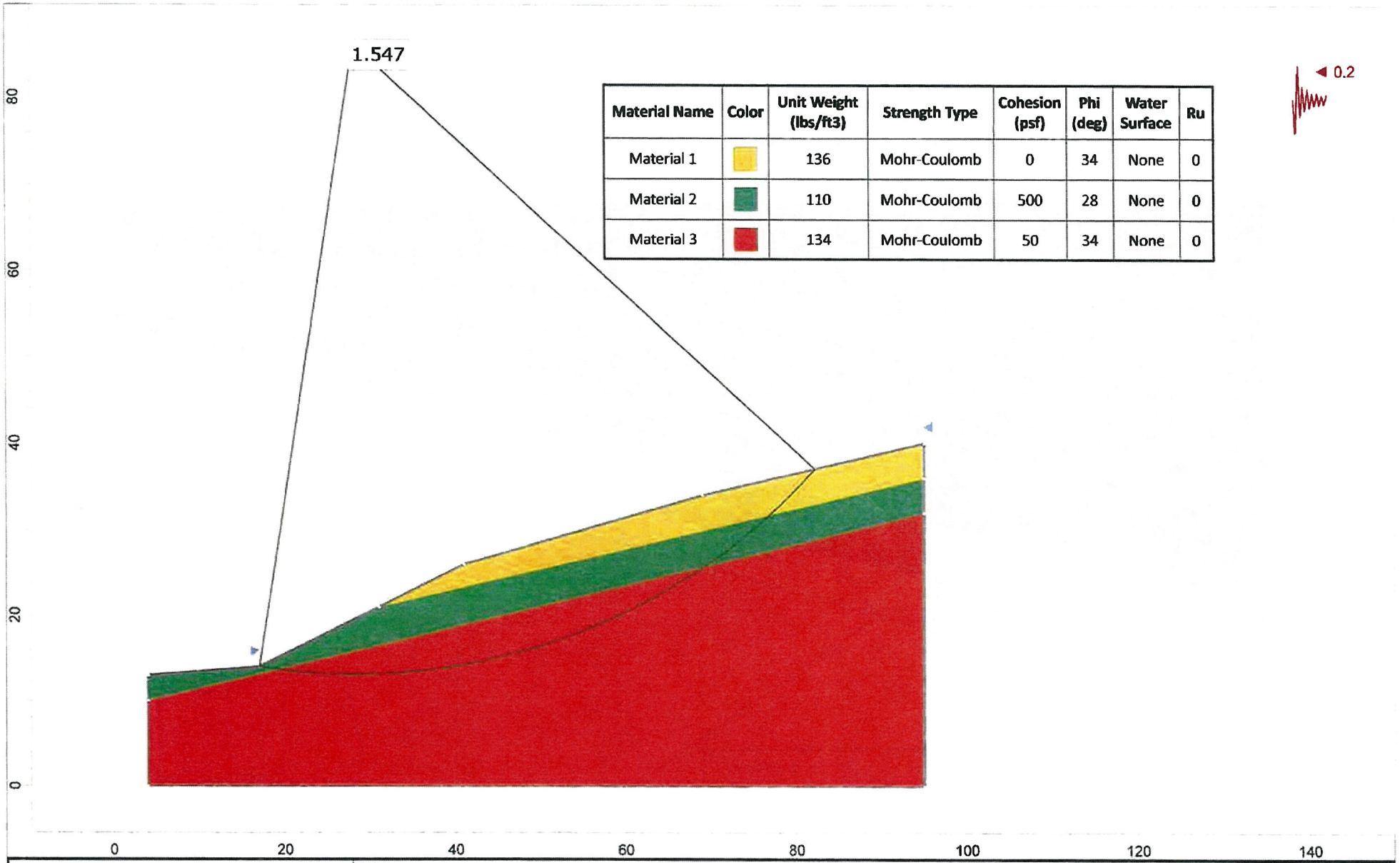



| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Ru |
|---|---|---|---|---|---|---|---|
| Material 1 | | 136 | Mohr-Coulomb | 0 | 34 | None | 0 |
| Material 2 | | 110 | Mohr-Coulomb | 500 | 28 | None | 0 |
| Material 3 | | 134 | Mohr-Coulomb | 50 | 34 | None | 0 |

rocscience

SLIDEINTERPRET 8.008

| | | | |
|---|---|---|---|
| Project | Aldarra Lot N | | |
| Analysis Description | B-B' Static | | |
| Drawn By | JCS | Company | Terra Associates, Inc. |
| Date | 6/7/2018 | File Name | B-B.slmd |




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Ru |
|---|---|---|---|---|---|---|---|
| Material 1 | | 136 | Mohr-Coulomb | 0 | 34 | None | 0 |
| Material 2 | | 110 | Mohr-Coulomb | 500 | 28 | None | 0 |
| Material 3 | | 134 | Mohr-Coulomb | 50 | 34 | None | 0 |

| | | | |
|---|---|---|---|
| Project | Aldarra Lot N | | |
| Analysis Description | B-B' Pseudostatic | | |
| Drawn By | JCS | Company | Terra Associates, Inc. |
| Date | 6/7/2018 | File Name | B-B.slmd |

SLIDEINTERPRET 8.008

# *Appendix C*

## MGS Flood Calculations

# MGS FLOOD
# PROJECT REPORT

Input File Name: **Existing Conditions Evaluation**
Project Name: Aldarra
Analysis Title: Detention Pond
Comments: Total site area = 152.1 ac

## PRECIPITATION INPUT

Computational Time Step (Minutes): 60

Extended Precipitation Time Series Selected
Climatic Region Number: 18

Full Period of Record Available used for Routing
Precipitation Station : 96005205 Puget East 52 in_5min 10/01/1939-10/01/2097
Evaporation Station : 961052 Puget East 52 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********** Default HSPF Parameters Used (Not Modified by User) **********

## ********** WATERSHED DEFINITION **********

**Predevelopment/Post Development Tributary Area Summary**

| | Predeveloped | Post Developed |
|---|---|---|
| Total Subbasin Area (acres) | 143.100 | 152.100 |
| Area of Links that Include Precip/Evap (acres) | 0.000 | 0.000 |
| Total (acres) | 143.100 | 152.100 |

**----------SCENARIO: PREDEVELOPED**
Number of Subbasins: 1

---------- Subbasin : Subbasin 1 ----------

| | -------Area (Acres) -------- |
|---|---|
| Till Forest | 30.700 |
| Till Pasture | 103.600 |
| Till Grass | 6.000 |
| Impervious | 2.800 |
| Subbasin Total | 143.100 |

**----------SCENARIO: POSTDEVELOPED**
Number of Subbasins: 1

---------- Subbasin : Subbasin 1 ----------

| | -------Area (Acres) -------- |
|---|---|
| Till Forest | 1.000 |

| | |
|---|---|
| Till Pasture | 5.500 |
| Till Grass | 99.500 |
| Impervious | 46.100 |
| Subbasin Total | 152.100 |

********** **LINK DATA** **********

----------SCENARIO: POSTDEVELOPED
Number of Links: 1

**----------**
**Link Name: New Structure Lnk1**
Link Type: Structure
Downstream Link: None

User Specified Elevation Volume Table Used

| Elevation (ft) | Pond Volume (cu-ft) |
|---|---|
| 100.15 | 0. |
| 100.16 | 981. |
| 100.70 | 54732. |
| 101.00 | 85270. |
| 101.10 | 95558. |
| 101.20 | 105898. |
| 101.30 | 116293. |
| 101.40 | 126741. |
| 101.50 | 137243. |
| 102.00 | 190560. |
| 102.50 | 245086. |
| 103.00 | 300685. |
| 103.50 | 357358. |
| 104.00 | 415105. |
| 104.50 | 473937. |
| 104.87 | 518179. |
| 105.00 | 533866. |
| 105.10 | 545983. |
| 105.30 | 570349. |
| 105.50 | 594805. |
| 106.00 | 656926. |
| 106.50 | 720155. |
| 106.80 | 758630. |
| 107.15 | 804027. |
| 108.22 | 946220. |
| 108.25 | 950282. |
| 108.40 | 970653. |
| 108.65 | 1004836. |
| 108.90 | 1039308. |
| 109.43 | 1113014. |
| 109.45 | 1116380. |
| 110.00 | 1193860. |
| 110.50 | 1266222. |
| 110.90 | 1324946. |
| 111.60 | 1429495. |
| 111.70 | 1444616. |
| 111.80 | 1459784. |
| 112.00 | 1490257. |
| 112.31 | 1537868. |

112.40 1551778.

Massmann Infiltration Option Used
Hydraulic Conductivity (in/hr) : 0.00
Depth to Water Table (ft) : 100.00
Bio-Fouling Potential : Low
Maintenance : Average or Better

Riser Geometry
Riser Structure Type : Rectangular
Riser Length (ft) : 8.00
Riser Width (ft) : 0.50
Common Length (ft) : 0.000
Riser Crest Elevation : 112.25 ft

Hydraulic Structure Geometry

Number of Devices: 6

---Device Number 1 ---
Device Type : Circular Orifice
Control Elevation (ft) : 109.43
Diameter (in) : 11.50
Orientation : Horizontal
Elbow : Yes

---Device Number 2 ---
Device Type : Circular Orifice
Control Elevation (ft) : 104.87
Diameter (in) : 7.25
Orientation : Vertical
Elbow : Yes

---Device Number 3 ---
Device Type : Circular Orifice
Control Elevation (ft) : 97.86
Diameter (in) : 7.25
Orientation : Horizontal
Elbow : No

---Device Number 4 ---
Device Type : Circular Orifice
Control Elevation (ft) : 109.78
Diameter (in) : 8.50
Orientation : Horizontal
Elbow : Yes

---Device Number 5 ---
Device Type : Circular Orifice
Control Elevation (ft) : 108.28
Diameter (in) : 7.25
Orientation : Horizontal
Elbow : Yes

---Device Number 6 ---
Device Type : Circular Orifice
Control Elevation (ft) : 108.05
Diameter (in) : 7.25
Orientation : Horizontal

Elbow : Yes

**********FLOOD FREQUENCY AND DURATION STATISTICS**********

----------SCENARIO: PREDEVELOPED
Number of Subbasins: 1
Number of Links: 0

----------SCENARIO: POSTDEVELOPED
Number of Subbasins: 1
Number of Links: 1

********** Link: New Structure Lnk1 ********** Link WSEL Stats
WSEL Frequency Data(ft)
(Recurrence Interval Computed Using Gringorten Plotting Position)

| Tr (yrs) | WSEL Peak (ft) |
|---|---|
| 1.05-Year | 102.212 |
| 1.11-Year | 102.564 |
| 1.25-Year | 103.216 |
| 2.00-Year | 104.935 |
| 3.33-Year | 105.713 |
| 5-Year | 106.525 |
| 10-Year | 108.082 |
| 25-Year | 109.448 |
| 50-Year | 109.810 |
| 100-Year | 109.931 |

**********Groundwater Recharge Summary **********
Recharge is computed as input to Perlnd Groundwater Plus Infiltration in Structures

Total Predeveloped Recharge During Simulation

| Model Element | Recharge Amount (ac-ft) |
|---|---|
| Subbasin: Subbasin 1 | 29593.750 |
| Total: | 29593.750 |

Total Post Developed Recharge During Simulation

| Model Element | Recharge Amount (ac-ft) |
|---|---|
| Subbasin: Subbasin 1 | 15606.410 |
| Link: New Structure Lnk1 | 0.000 |
| Total: | 15606.410 |

**Total Predevelopment Recharge is Greater than Post Developed**
**Average Recharge Per Year, (Number of Years= 158)**
**Predeveloped: 187.302 ac-ft/year, Post Developed: 98.775 ac-ft/year**

********** Link: New Structure Lnk1 **********

Basic Wet Pond Volume (91% Exceedance): 452209. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 678314. cu-ft

Infiltration/Filtration Statistics----------
Inflow Volume (ac-ft): 62453.46
Inflow Volume Including PPT-Evap (ac-ft): 62453.46
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
Total Runoff Filtered (ac-ft): 0.00, 0.00%
Primary Outflow To Downstream System (ac-ft): 251283.50
Secondary Outflow To Downstream System (ac-ft): 0.00
Percent Treated (Infiltrated+Filtered)/Total Volume: 0.00%

**********Compliance Point Results **********

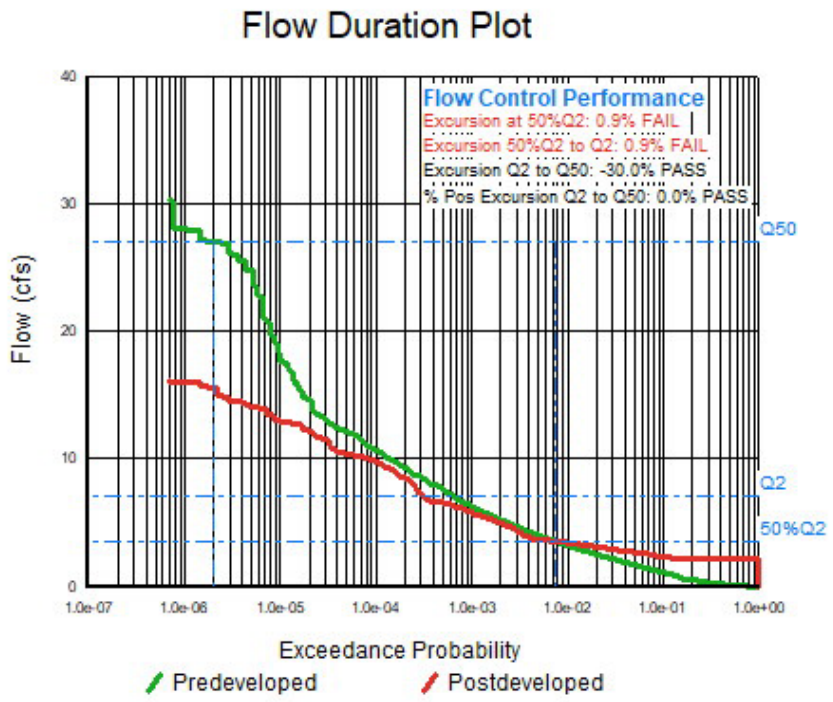
Scenario Predeveloped Compliance Subbasin: Subbasin 1

Scenario Postdeveloped Compliance Link: New Structure Lnk1

*** Point of Compliance Flow Frequency Data ***
Recurrence Interval Computed Using Gringorten Plotting Position

| Predevelopment Runoff | | Postdevelopment Runoff | |
|---|---|---|---|
| Tr (Years) | Discharge (cfs) | Tr (Years) | Discharge (cfs) |
| 2-Year | 7.049 | 2-Year | 3.747 |
| 5-Year | 11.513 | 5-Year | 5.678 |
| 10-Year | 14.826 | 10-Year | 6.981 |
| 25-Year | 22.946 | 25-Year | 10.816 |
| 50-Year | 26.924 | 50-Year | 13.394 |
| 100-Year | 27.983 | 100-Year | 14.399 |
| 200-Year | 29.546 | 200-Year | 15.551 |

** Record too Short to Compute Peak Discharge for These Recurrence Intervals



# MGS FLOOD
# PROJECT REPORT

Input File Name: New Flow Control Calculations.fld
Project Name: Aldarra
Analysis Title: Detention Pond
Comments: Total site area = 152.1 ac

## PRECIPITATION INPUT

Computational Time Step (Minutes): 60

Extended Precipitation Time Series Selected
Climatic Region Number: 18

Full Period of Record Available used for Routing
Precipitation Station : 96005205 Puget East 52 in_5min 10/01/1939-10/01/2097
Evaporation Station : 961052 Puget East 52 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********** Default HSPF Parameters Used (Not Modified by User) **********

********** **WATERSHED DEFINITION** **********

**Predevelopment/Post Development Tributary Area Summary**

| | Predeveloped | Post Developed |
|---|---|---|
| Total Subbasin Area (acres) | 143.100 | 152.100 |
| Area of Links that Include Precip/Evap (acres) | 0.000 | 0.000 |
| Total (acres) | 143.100 | 152.100 |

**----------SCENARIO: PREDEVELOPED**
Number of Subbasins: 1

---------- Subbasin : Subbasin 1 ----------

| | -------Area (Acres) -------- |
|---|---|
| Till Forest | 53.700 |
| Till Pasture | 80.600 |
| Till Grass | 6.000 |
| Impervious | 2.800 |
| Subbasin Total | 143.100 |

**----------SCENARIO: POSTDEVELOPED**
Number of Subbasins: 1

---------- Subbasin : Subbasin 1 ----------

| | -------Area (Acres) -------- |
|---|---|
| Till Forest | 1.000 |
| Till Pasture | 5.500 |
| Till Grass | 98.350 |
| Impervious | 47.250 |

---
Subbasin Total 152.100

********** **LINK DATA** **********

----------SCENARIO: POSTDEVELOPED
Number of Links: 1

---
**Link Name: New Structure Lnk1**
Link Type: Structure
Downstream Link: None

User Specified Elevation Volume Table Used

| Elevation (ft) | Pond Volume (cu-ft) |
|---|---|
| 100.15 | 0. |
| 100.16 | 981. |
| 100.70 | 54732. |
| 101.00 | 85270. |
| 101.10 | 95558. |
| 101.20 | 105898. |
| 101.30 | 116293. |
| 101.40 | 126741. |
| 101.50 | 137243. |
| 102.00 | 190560. |
| 102.50 | 245086. |
| 103.00 | 300685. |
| 103.50 | 357358. |
| 104.00 | 415105. |
| 104.50 | 473937. |
| 104.87 | 518179. |
| 105.00 | 533866. |
| 105.10 | 545983. |
| 105.30 | 570349. |
| 105.50 | 594805. |
| 106.00 | 656926. |
| 106.50 | 720155. |
| 106.80 | 758630. |
| 107.15 | 804027. |
| 108.22 | 946220. |
| 108.25 | 950282. |
| 108.40 | 970653. |
| 108.65 | 1004836. |
| 108.90 | 1039308. |
| 109.43 | 1113014. |
| 109.45 | 1116380. |
| 110.00 | 1193860. |
| 110.50 | 1266222. |
| 110.90 | 1324946. |
| 111.60 | 1429495. |
| 111.70 | 1444616. |
| 111.80 | 1459784. |
| 112.00 | 1490257. |
| 112.31 | 1537868. |
| 112.40 | 1551778. |

Massmann Infiltration Option Used
Hydraulic Conductivity (in/hr) : 0.00

Depth to Water Table (ft) : 100.00
Bio-Fouling Potential : Low
Maintenance : Average or Better

Riser Geometry
Riser Structure Type : Rectangular
Riser Length (ft) : 8.00
Riser Width (ft) : 0.50
Common Length (ft) : 0.000
Riser Crest Elevation : 112.25 ft

Hydraulic Structure Geometry

Number of Devices: 6

---Device Number 1 ---
Device Type : Circular Orifice
Control Elevation (ft) : 109.43
Diameter (in) : 11.50
Orientation : Horizontal
Elbow : Yes

---Device Number 2 ---
Device Type : Circular Orifice
Control Elevation (ft) : 104.87
Diameter (in) : 7.25
Orientation : Vertical
Elbow : Yes

---Device Number 3 ---
Device Type : Circular Orifice
Control Elevation (ft) : 97.86
Diameter (in) : 6.75
Orientation : Horizontal
Elbow : No

---Device Number 4 ---
Device Type : Circular Orifice
Control Elevation (ft) : 109.78
Diameter (in) : 8.50
Orientation : Horizontal
Elbow : Yes

---Device Number 5 ---
Device Type : Circular Orifice
Control Elevation (ft) : 108.28
Diameter (in) : 7.25
Orientation : Horizontal
Elbow : Yes

---Device Number 6 ---
Device Type : Circular Orifice
Control Elevation (ft) : 108.05
Diameter (in) : 7.25
Orientation : Horizontal
Elbow : Yes

**********FLOOD FREQUENCY AND DURATION STATISTICS**********

**----------SCENARIO: PREDEVELOPED**
Number of Subbasins: 1
Number of Links: 0

**----------SCENARIO: POSTDEVELOPED**
Number of Subbasins: 1
Number of Links: 1

********** Link: New Structure Lnk1 ********** Link WSEL Stats
WSEL Frequency Data(ft)
(Recurrence Interval Computed Using Gringorten Plotting Position)

| Tr (yrs) | WSEL Peak (ft) |
|---|---|
| 1.05-Year | 102.542 |
| 1.11-Year | 102.891 |
| 1.25-Year | 103.783 |
| 2.00-Year | 105.468 |
| 3.33-Year | 106.244 |
| 5-Year | 107.049 |
| 10-Year | 108.597 |
| 25-Year | 109.670 |
| 50-Year | 110.102 |
| 100-Year | 110.422 |

************Groundwater Recharge Summary **************
Recharge is computed as input to Perlnd Groundwater Plus Infiltration in Structures

Total Predeveloped Recharge During Simulation

| Model Element | Recharge Amount (ac-ft) |
|---|---|
| Subbasin: Subbasin 1 | 29851.600 |
| Total: | 29851.600 |

Total Post Developed Recharge During Simulation

| Model Element | Recharge Amount (ac-ft) |
|---|---|
| Subbasin: Subbasin 1 | 15442.050 |
| Link: New Structure Lnk1 | 0.000 |
| Total: | 15442.050 |

**Total Predevelopment Recharge is Greater than Post Developed**
**Average Recharge Per Year, (Number of Years= 158)**
**Predeveloped: 188.934 ac-ft/year, Post Developed: 97.735 ac-ft/year**

************Water Quality Facility Data **************

**----------SCENARIO: PREDEVELOPED**

Number of Links: 0

**----------SCENARIO: POSTDEVELOPED**

Number of Links: 1

********** Link: New Structure Lnk1 **********

Basic Wet Pond Volume (91% Exceedance): 455997. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 683996. cu-ft

Infiltration/Filtration Statistics----------
Inflow Volume (ac-ft): 62759.06
Inflow Volume Including PPT-Evap (ac-ft): 62759.06
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
Total Runoff Filtered (ac-ft): 0.00, 0.00%
Primary Outflow To Downstream System (ac-ft): 220623.60
Secondary Outflow To Downstream System (ac-ft): 0.00
Percent Treated (Infiltrated+Filtered)/Total Volume: 0.00%

**********Compliance Point Results **********

Scenario Predeveloped Compliance Subbasin: Subbasin 1

Scenario Postdeveloped Compliance Link: New Structure Lnk1

*** Point of Compliance Flow Frequency Data ***
Recurrence Interval Computed Using Gringorten Plotting Position

| Predevelopment Runoff | | Postdevelopment Runoff | |
|---|---|---|---|
| Tr (Years) | Discharge (cfs) | Tr (Years) | Discharge (cfs) |
| 2-Year | 6.664 | 2-Year | 4.081 |
| 5-Year | 11.183 | 5-Year | 5.511 |
| 10-Year | 13.971 | 10-Year | 8.172 |
| 25-Year | 21.859 | 25-Year | 12.000 |
| 50-Year | 24.837 | 50-Year | 14.700 |
| 100-Year | 25.348 | 100-Year | 16.163 |
| 200-Year | 25.837 | 200-Year | 16.404 |

** Record too Short to Compute Peak Discharge for These Recurrence Intervals

**** Flow Duration Performance ****

| | | |
|---|---|---|
| Excursion at Predeveloped 50%Q2 (Must be Less Than or Equal to 0%): | -21.2% | PASS |
| Maximum Excursion from 50%Q2 to Q2 (Must be Less Than or Equal to 0%): | -3.5% | PASS |
| Maximum Excursion from Q2 to Q50 (Must be less than 10%): | 4.1% | PASS |
| Percent Excursion from Q2 to Q50 (Must be less than 50%): | 2.1% | PASS |

---
MEETS ALL FLOW DURATION DESIGN CRITERIA: PASS
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